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A Note on Aseroe rubra (La Bill.) Fries var. ceylanica (Berk.) Ed. Fischer from South India

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The only species of the genus *Aseroe* so far reported from India is *A. arachnoidea* Fischer collected by Narasimhan (1932) in the Western Ghats region of the Mysore State. Another species of the genus was collected during recent years by Mr. V. S. Seshadri, Assistant Professor of Botany, Presidency College, Madras, during two botanical tours of his college, one to Kodaikanal in the Pulney Hills in September, 1948 and another to Munnar in the Western Ghats near the Travancore-Madras border in September, 1949. Altogether five specimens of the phalloid were collected by him, one specimen in the Tiger Shola, at Kodaikanal, at an elevation of about 5,000 feet, and four specimens at Munnar, at an elevation of about 4,500 feet. Mr. Seshadri and Professor C. B. Rao, Head of the Botany Department of Presidency College, very kindly placed these five specimens at our disposal. We wish to express our sincere thanks for this kindness.

These five specimens have been referred by us to *Aseroe rubra* (La Bill.) Fries var. *ceylanica* (Berk.) Ed. Fischer. An account of them is given below.

This phalloid has a receptacle with a hollow stem which is broadened at the top into a saucer-like portion or disc, from the border of which arise 16 to 18 arms, spreading in a more or less radiate manner. The arms are either completely free from one another, or disposed in pairs, or some disposed in pairs and others free. The arms are broad at the base and taper to a fine point. The tips of the arms are slightly curled. The bases of two adjacent arms or pairs of arms are separated by a broad rounded sinus. The stem is tubular and open at the top. This open end of the stem is surrounded by the broad disc. The gleba lies on the inner part of the disc and covers the open end of the stem. The portion of the disc occupied by the gleba is highly wrinkled with a number of small projections on the surface. A fairly wide border is present in the disc, between the portion occupied by the gleba and the base of the arms.

The gleba is bluish green in color. The part of the border immediately surrounding the gleba is dark purple and the extreme margin of

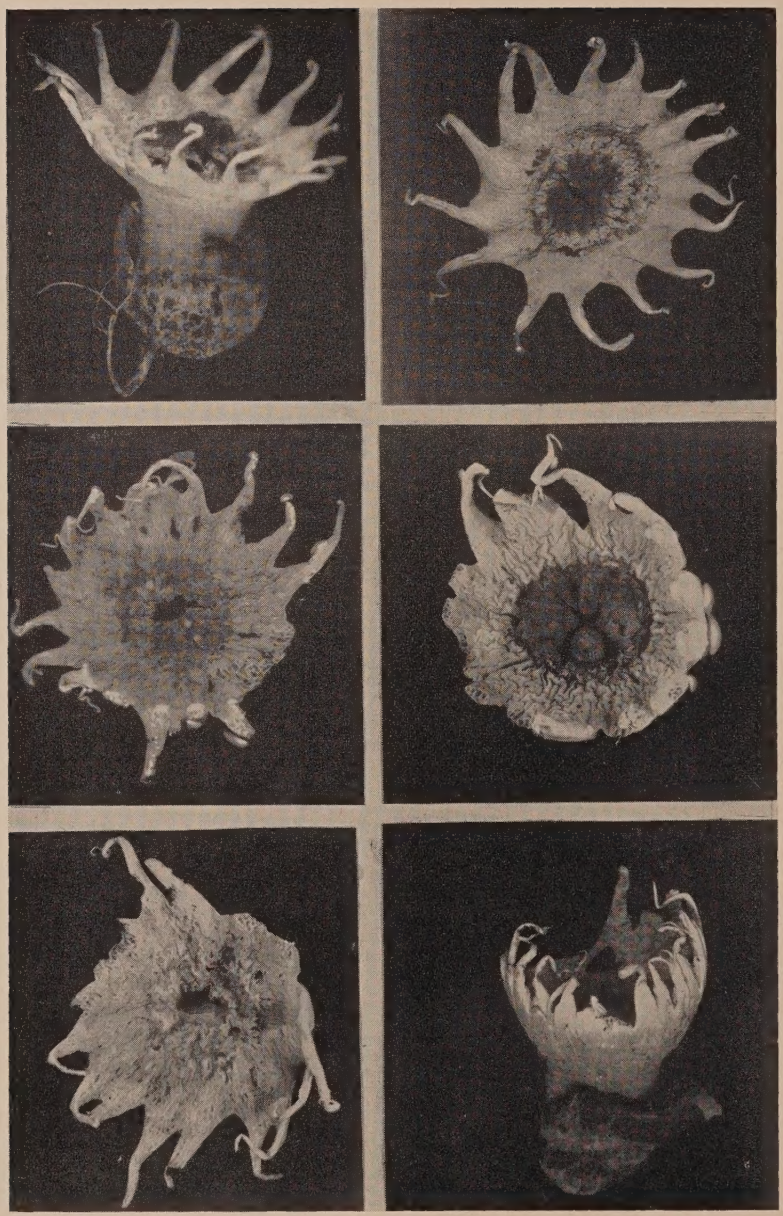
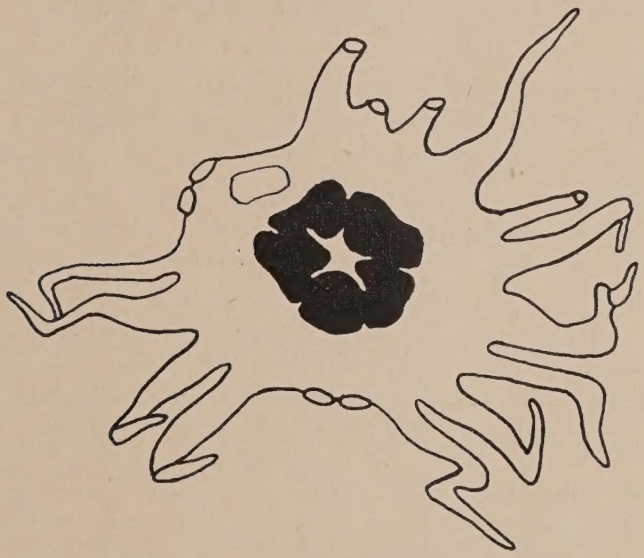


PLATE 1.—*Aseroe rubra* (La Bill.) Fries var. *ceylanica* (Berk.) Ed. Fischer. FIG. 1. Specimen 1, side view. FIG. 2. Specimen 1, disc-view. FIG. 3. Specimen 2, disc-view. FIG. 4. Specimen 3, disc-view. FIG. 5. Specimen 4, disc-view. FIG. 6. Specimen 5, side view. FIGS. 1–2, upper row; FIGS. 3–4, middle row; FIGS. 5–6, lower row.

the disc and the arms are dark red. The stem is orange-red in color, gradually becoming lighter in color towards the base. The volva is dirty white in color.

The stem is 3.2 to 4 cm. high, and 1.5 cm. in thickness at the top. The arms are 1.5 to 2.6 cm. long, and the disc 3.4 to 3.6 cm. in diameter. The border of the disc surrounding the gleba is 8 to 10 mm. wide. The distance from tip to tip of the opposing arms is 6.5 to 7.8 cm. The volva is 2 cm. high and 1.6 to 2 cm. broad. The spores are 4.2 to 5.6 μ long and 1.4 to 2.8 μ broad.

All five specimens were growing on the ground, in moist humous soil, in deep shade. Specimen 1 was growing at Kodaikanal and specimens 2 to 5 were growing at Munnar.



Text—FIG. 1. *Aseroe rubra* (La Bill.) Fries var. *ceylanica* (Berk.) Ed. Fischer. Disc-view of specimen 5, (drawn after gently pressing the arms flat by means of a glass plate to show the arrangement of the arms).

The arms in the five specimens are not uniformly disposed, but show variations in their arrangement, as briefly stated below:

Specimen 1, (Pl. 1, figs, 1, 2), has sixteen arms. There is no pairing of any of the arms. All the arms are single.

Specimen 2, (Pl. 1, fig. 3) has eighteen arms, of which four are cut off nearly to the base, probably eaten off by some insect or other animal. The remaining fourteen arms are complete. All the eighteen arms appear to be single.

Specimen 3, (Pl. 1, fig. 4) has sixteen arms of which only three are complete. Of the remaining thirteen arms, four are cut off at about the middle and the other nine cut off almost to the base. But the basal portions of these nine arms are intact and so the nature of their arrangement could be clearly made out. Of the sixteen arms, ten are disposed in pairs and the others are single.

Specimen 4, (Pl. 1, fig. 5) has sixteen arms of which eleven are intact, while the remaining five are cut off very close to the base. Of the eleven arms which are intact, one is single and the remaining ten are definitely disposed in pairs. Of the five arms which are cut off, two appear to form a pair and the disposition of the other three arms could not be made out.

Specimen 5, (Pl. 1, fig. 6; Text-fig. 1) has eighteen arms of which fourteen are intact, while the remaining four are cut off somewhat close to the base. Of the fourteen complete arms, ten are definitely in pairs. The remaining four arms at first sight appear to be single, but on closer examination appear to be really paired. The four arms which are cut off are in pairs.

The measurements and other details are given in Table 1.

TABLE 1

SPECIMEN NUMBER	LOCALITY	NO. OF ARMS	NO. OF PAIRED AND UNPAIRED ARMS	HEIGHT OF STEM	THICKNESS OF STEM
1.	Kodaikanal	16	All arms unpaired	3.5 cm.	1.5 cm.
2.	Munnar	18	All arms unpaired	3.5 cm.	1.5 cm.
3.	—do—	16	10 paired and 6 unpaired	4 cm.	1.5 cm.
4.	—do—	16	*12 paired	3.6 cm.	1.5 cm.
5.	—do—	18	All arms paired	3.2 cm.	1.6 cm.

*Four arms missing.

SPECIMEN NUMBER	DIAM. OF DISC	DISC MARGIN	LENGTH OF ARMS	DISTANCE FROM TIP TO TIP OF ARMS	HEIGHT AND BREADTH OF VOLVA	SPORE SIZE
1.	3.5 cm.	8 mm.	1.5–1.8 cm.	6.5 cm.	2 x 1.6 cm.	4.2–5.6 X 1.4–2.8 u.
2.	3.5 cm.	10 mm.	1.5–2.2 cm.	6.5 cm.	volva missing	—do—
3.	3.5 cm.	10 mm.	1.8–2.4 cm.	**..	2 x 2 cm.	—do—
4.	3.6 cm.	10 mm.	1.8–2.4 cm.	7.8 cm.	volva missing	—do—
5.	3.4 cm.	10 mm.	2–2.6 cm.	7.8 cm.	2 x 2 cm.	—do—

**Measurement not taken as most of the arms were found cut off.

Berkely (1846, p. 535; 1847, p. 512) gave an account of a phalloid collected by Gardner in Ceylon, and described it as a new species, which he called *A. zeylanica*. Fischer (1888) considered it at first as a separate species, but later on decided that it was only a variety of *A. rubra* La Bill. (1890, p. 75; 1893, p. 30; 1933, p. 93).

In 1908, Bernard gave an account of a few specimens of an *Aseroe* from Java, which he referred to *A. rubra* La Bill. var. *Junghuhnii* Schlechtendal. Since he found in his specimens a number of transitional forms connecting var. *Junghuhnii* with var. *ceylanica*, he suggested

that these two varieties are identical and should be merged under one name. He stressed this view again in 1909, in a note which he published in "Synopsis of the known Phalloids" by C. G. Lloyd (1909, pp. 92–4). In this note he also gave two good photographs, which were the first ones published of this phalloid.

Petch, in 1908, gave an account of three specimens of an *Aseroe rubra*, which he collected in Ceylon. He found that all of the arms in these specimens were single and none paired, but stated that Mr. E. E. Green saw the same species in plantations in the uplands of Ceylon, with all arms paired or with the arms split for half their length. Petch stated again that a smaller specimen, which was collected by Mr. J. F. Jowitt on the island, had sixteen arms obscurely arranged in pairs. In 1911, Petch gave an account of six more specimens of this phalloid from Ceylon, accompanied by two excellent photographs of a specimen. In these specimens, some had all the arms paired, some all the arms single, and some a few of the arms paired and the remaining arms single. The specimens with paired arms resembled completely var. *typica*. But in var. *typica*, according to Fischer, (1890, p. 72), the sporemass covers not only the disc but also the upper surfaces of the arms up to the place of their forking. Petch had clearly stated that in his specimens, the gleba did not reach the arms and that there was a wide border of the disc surrounding the gleba (1908, pp. 177–8). Therefore he was in error in stating that the Ceylon specimens with paired arms agreed in all respects with var. *typica*. On the presumption that his specimens with paired arms agreed in all respects with var. *typica*, he stated that his specimens showed all gradations from var. *typica* to var. *ceylanica*. He would have been correct, had he stated that his specimens showed all stages between var. *Junghuhnii* and var. *ceylanica*, but not between var. *typica* and var. *ceylanica*. Referring his Ceylon specimens to *A. rubra* La Bill. without recognizing any of the varieties of Fischer, is therefore, quite unwarranted.

Of the five specimens dealt with in this paper, in two specimens, all the arms are single and unpaired as in var. *ceylanica*, in one specimen all the arms are in pairs as in var. *Junghuhnii* and in the remaining two specimens, some of the arms are paired and the remaining ones single. Since these five specimens show the features of both var. *Junghuhnii* and var. *ceylanica*, and also all the transitional forms between the two varieties, they lend full support to Bernard's view that the two varieties should be merged under one name. In fact, as Bernard has pointed out, Fischer himself, in 1888 (Saccardo, VII, p. 25), asks the question whether *A. Junghuhnii* Schlechtendal is really different from *A. zeylanica* Berk.

From the foregoing it would appear to be quite clear that the two varieties, var. *Junghuhnii* and var. *ceylanica*, cannot be kept separate, and that it would be more reasonable to merge them under one name. Since *A. zeylanica* was established earlier, the writers suggest that these two varieties be merged under the name var. *ceylanica* (Berk.) Ed. Fischer.

SUMMARY

Of five specimens of an *Aseroe* collected in South India some show

features of *Aseroe rubra* (La Bill.) Fries var. *Junghuhnii* Schlechtendal and some those of *A. rubra* (La Bill.) Fries var. *ceylanica* (Berk.) Ed. Fischer, while others show features intermediate between these two varieties. Since these specimens show all variations between the two varieties, these two varieties may be merged under one name, as already suggested by Bernard. It is suggested that var. *Junghuhnii* be included in var. *ceylanica*, the latter being the older name.

This is the first record of the occurrence of this phalloid in India.

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Embryological Studies in the Leguminosae

VI. Inflorescence, Sporogenesis, and Gametophytes of Dichrostachys cinerea W. & A. and Parkia biglandulosa W. & A.

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Dichrostachys cinerea and *Parkia biglandulosa* are members of the Mimosaceae. The former is a large branched shrub with its characteristic numerous branchlets ending in terminal straight thorns and the latter is a very beautiful, tall, unarmed tree with large fleshy leaves.

MATERIAL AND METHODS

The material of *Dichrostachys cinerea* was supplied by Prof. Venkateswarlu from Waltair and by Dr. Subramanyam from Bangalore and that of *Parkia biglandulosa* was collected in the Marharajbagh Gardens, Nagpur. It was fixed in formalin-acetic-alcohol and Randolph's modification of Navaschin's fluid (Johansen, 1940). The sections were cut at a thickness of 8–15 μ and were stained with iron-alum haematoxylin, Harris' haematoxylin and Earlich's haematoxylin (Johansen).

THE INFLORESCENCE AND THE FLOWER

The inflorescence and flowers of *Dichrostachys cinerea* have been recently described in detail by Venkatesh (1951). The inflorescence is a pretty tassel like stalked axillary spike bearing polygamous flowers. Some members of the Mimosaceae like *Neptunia oleracea* (Geitler, 1927) and *Neptunia triquetra* (Dnyansagar, 1952) bear polygamous flowers. The lower flowers in the inflorescence are sterile with long staminodes of bright rose color which are more prominent than sepals or petals. The upper region bears fertile flowers which are bright yellow and usually shorter having the floral formula K (5), C (5), A10, $G\underline{1}$. The stamens are exserted and bear four-celled anthers, the connective of each of which is prolonged into a prominent stipitate gland. A few flowers of an intermediate nature are inserted between the fertile and sterile flowers. This arrangement indicates a division of labor, the sterile flowers serving to attract insects as in *Neptunia oleracea* (Geitler, 1927) and *Neptunia triquetra* (Dnyansagar, 1952).

The inflorescence of *Parkia biglandulosa* is a dense long peduncled drooping head which looks very much like a deep brown colored velvet ball, when the flowers are in bud. Each inflorescence consists of a large fleshy spherical disc or receptacle on which are born numerous narrow flowers. These are tubular and white. The stamens are exserted and monadelphous. They become connate with the corolla tube. The floral formula is K (5), A (10), $G\underline{1}$.

The floral parts arise in acropetal succession and are cyclic in arrangement.

MICROSPOROGENESIS

The young anther is at first a homogeneous mass of cells and is almost circular in transverse section. Gradually it becomes squarish and then four-lobed. In *Dichrostachys cinerea*, a plate of hypodermal archesporial tissue differentiates in each lobe. The outer layer of the archesporium cuts off the primary parietal layer. The latter divides to form two layers, of which the inner is the tapetum (Figs. 1 and 2). The outer one again divides and gives rise to the endothecium and the middle layer (Pl. 1, Fig. 3). In some cases the latter may again divide to form two middle layers.

The sporogenous cells divide both vertically and transversely and form microspore mother-cells which are polygonal in outline. Each anther-lobe shows usually two to four vertical rows of 6–12 microspore mother-cells which are closely packed together and possess densely staining cytoplasm (Pl. 1, Fig. 1a). Later, the microspore mother-cells in each vertical row become arranged in groups of 2 to 8 (Pl. 1, Figs. 1b and 2) which arrangement presents a striking appearance and is a characteristic feature of the plant. The mother-cells in each group undergo two reduction divisions which are simultaneous (Figs. 3, 4 and Pl. 1, Fig. 6). Cytokinesis occurs by furrowing. The reduction divisions, however, may not take place simultaneously in all groups (Pl. 1, Fig. 4). Ultimately, each group develops a pollinium, the number of cells composing it varying from 8–16 (Pl. 1, Fig. 7).

Two interesting features have been observed in a few cases with regard to formation of a transverse septum in the anther-lobe. Usually, there is no development of a transverse septum in the anther-lobe and a layer of tapetum surrounds all sporogenous cells. But in a few cases, a transverse septum of tapetal cells was formed partitioning the sporogenous mass of cells in each lobe into two compartments, each having a tapetal layer surrounding it on all sides (Pl. 1, Fig. 4). In one case, a sterile transverse septum consisting of cells from the middle layer was formed and on both sides of this septum, a tapetal layer developed with the result that the sporogenous cells in each compartment were nourished by its own tapetum (Pl. 1, Fig. 5).

In the case of intermediate flowers between fertile and sterile regions, the anthers even though four lobed, show only 1, 2 or 3 groups of archesporial cells.

In *Parkia biglandulosa*, the archesporial cells can only be distinguished after formation of one or two wall-layers (Pl. 2, Fig. 9). Their number in each lobe of the anther varies from 10–20 and these are arranged in a characteristically vertical row. Transverse sterile septa then appear between consecutive sporogenous cells so that each compartment contains only one sporogenous cell (Pl. 2, Fig. 9). This is the most interesting feature of the plant in regard to this part of its life-history. Each septum consists of 2 or 3 layers of sterile cells developed from the parietal tissue (Pl. 2, Figs. 11 and 12).

Formation of sterile septa in the anther-lobes has been reported in a few plants like *Dendropthoe* (Rauch, 1936), *Elytranthe* and *Amyema* (Schaeppi and Steindl, 1942) of the Loranthaceae, *Lemna* (Caldwell, 1899) and *Viscum* (Schaeppi and Steindl, 1945). Maheshwari (1950) states that this peculiar feature is present in some members of the Mimosaceae and quotes *Parkia* and *Dichrostachys* as examples (Engler 1876). No details in regard to their formation had, however, been previously worked out.

In *Parkia biglandulosa*, each archesporial cell cuts off a primary parietal cell. By its activity this cell forms a single layered tapetum around each sporogenous cell which undergoes two mitotic divisions to form a group of four microspore mother-cells. These cells of the

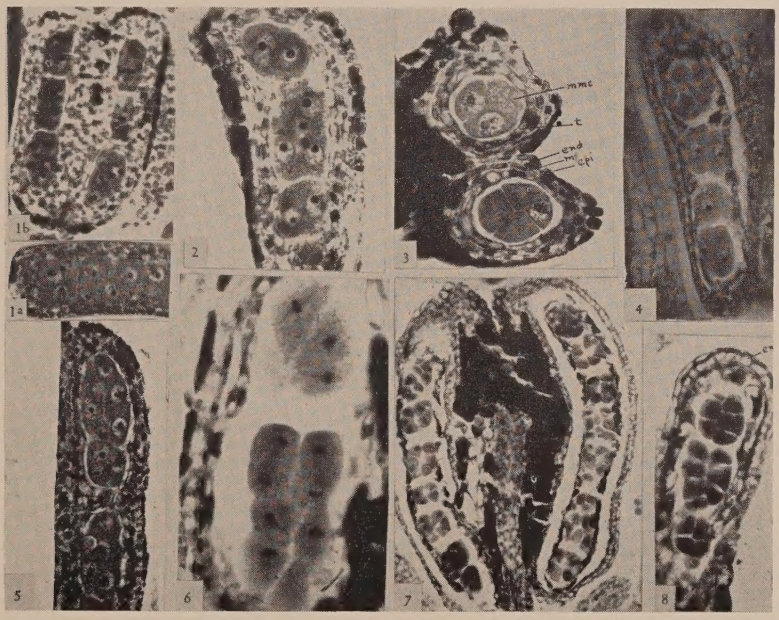


PLATE 1.—*Dichrostachys cinerea*—FIG. 1a. L. S. part of anther showing parietal tissue and packed microspore mother-cells, × 225. FIG. 1b. L. S. anther showing separation of microspore mother-cells in 3 groups in each lobe. ×225. FIG. 2. L. S. anther-lobe showing enlarged microspore mother-cells which have separated in groups. × 360. FIG. 3. T. S. part of anther showing 2 microsporangia with microspore mother-cells, *mmc*, parietal tissue and epidermis; *t*, tapetum, *m*, middle layer, *end*, endothecium and *epi*, epidermis. × 180. FIG. 4. L. S. anther-lobe showing at the top a pollinium and below 3 groups of microspore mother-cells. The lobe has become partitioned into 2 compartments by the transverse septum of tapetal cells. × 135. FIG. 5. L. S. anther-lobe showing 2 compartments formed by the sterile transverse septum on both sides of which there are tapetal cells. In each compartment, there are microspore mother-cells. ×115. FIG. 6. L. S. part of anther showing microspore mother-cells undergoing meiotic divisions. × 375. FIG. 7. L. S. mature anther showing pollinia arranged in a vertical row in each lobe, middle layers disintegrated. Some pollinia are 8-celled formed by 2 isobilateral tetrads. × 65. FIG. 8. L. S. part of mature anther showing epidermis, endothecium, *end* with characteristic thickenings, disintegrating middle layers, tapetum and 3 pollinia. × 110.

group do not, however, separate. Meiosis (Figs. 9, 10, 12 and Pl. 2, Fig. 12) occurs in the same way as in *Dichrostachys cinerea* and a pollinium is formed from each group of the microspore mother-cells. Thus 10–20 pollinia are formed in each anther-lobe arranged in a vertical row and each one is nourished by its own tapetum (Pl. 2, Fig. 14). This is indeed an unusual feature.

According to Coulter and Chamberlain (1919), formation of sterile septa is for dividing a large mass for better nutrition. The author agrees with this view. Since in *Parkia biglandulosa* the anther-lobes are very much elongated and as many as 20 pollinia may be present in each lobe, it seems that formation of the tapetum for each pollinium would assure better nutrition. In *Dichrostachys cinerea*, a sterile septum is occasionally formed and followed by a separation of sporogenous cells into two compartments, each being surrounded by its own tapetum. Such an occasional development of sterile septa in this plant in which the number of pollinia is also fairly large, indicates therefore an attempt for improving the mode of nutrition a condition which has now become a permanent feature in *Parkia biglandulosa*.

This condition leads to the question of definition and number of microsporangia per anther. In this connection, it is worthwhile mentioning the case of *Lemna* (Caldwell, 1899) discussed by Coulter and Chamberlain (1919). Here the anther originally contains a single mass of archosporial cells which later is divided into four groups by the appearance of sterile plates and further, each group is surrounded by its own tapetum. In this way, it appears that the anther possesses four usual sporangia. If a single sporangium is the criterion, then this becomes a case of a single sporangium. If, on the other hand, a group of mother-cells is the criterion, the anther has four sporangia. Coulter and Chamberlain (1919) remark," the explanation probably lies in the fact that the whole outer layer of the periblem is capable of becoming transformed into an archesporium and that while in ordinary cases archesporial tissue is developed in four separate regions, in *Lemna*, the condition favours a more general development." They further favor a less rigid definition of a sporangium and use the term as one of convenience. On this basis, they consider the four groups of mother-cells in *Lemna* as four sporangia which have had an exceptional origin. In *Parkia biglandulosa*, conditions differ somewhat. Here in each lobe of the anther, several groups of mother-cells are formed and each is surrounded by its own tapetum. If the latter standpoint by Coulter and Chamberlain is accepted, then the anther of *Parkia biglandulosa* bears 40–80 microsporangia, a phenomenon unique among angiosperms. The author agrees with their view that the term sporangium should be used as one of convenience.

The tapetum in both plants is of the secretory type and its cells remain uninucleate throughout as in all investigated species of the Mimosaceae.

When the anther becomes mature, the endothecium acquires the usual fibrous thickenings and remains the only layer of the parietal tissue, the tapetum and middle layers being used up during sporogenesis (Pl. 1, Fig. 8 and Pl. 2, Fig. 16). In *Parkia biglandulosa*, at the time of dehiscence of the anther, the transverse sterile septa also disintegrate. Their remnants can be seen in a dehisced anther (Pl. 2, Fig. 16).

POLLINIA AND POLLEN-GRAINS

A mature pollinium of *Dichrostachys cinerea* is 50–60 μ in diameter, and that of *Parkia biglandulosa* is 70–90 μ in diameter. In the former, it usually consists of 8 or 16 grains. In the 8-celled pollinium when it

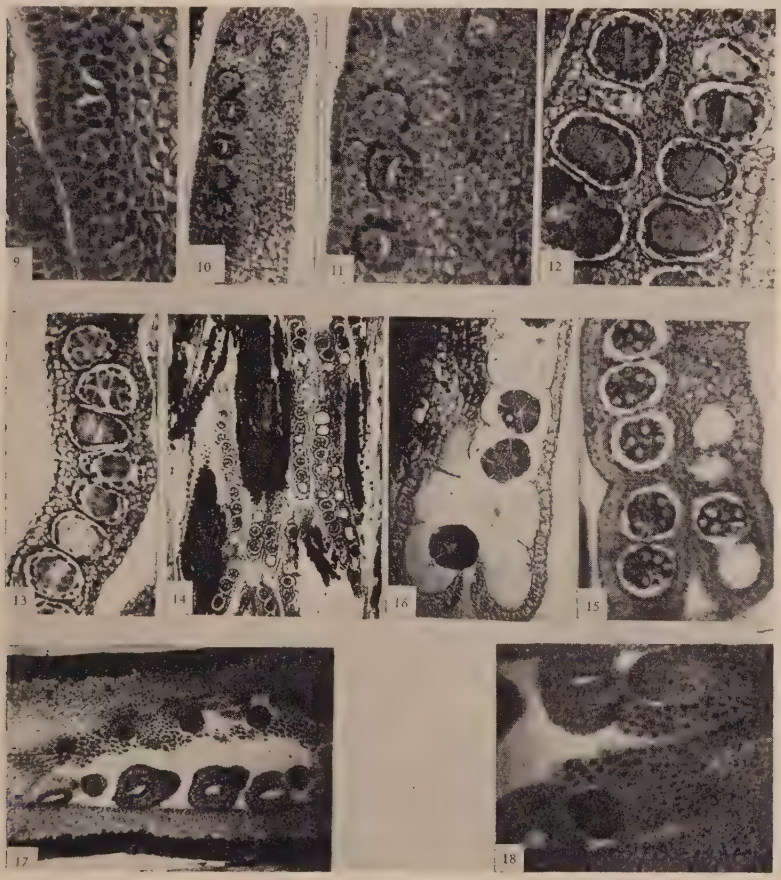


PLATE 2.—*Parkia biglandulosa*. FIG. 9. L. S. part of anther showing differentiation of sporogenous cells separated from one another by sterile septa. × 250. FIG. 10. L. S. part of anther showing spore mother-cells, each one being surrounded by its own tapetum. × 80. FIG. 11. Same as FIG. 10 but enlarged. × 250. FIG. 12. L. S. part of anther showing groups of microspore mother-cells, each group being separated by sterile septa and surrounded by its own tapetum. Some of the mother-cells are undergoing meiotic divisions. × 80. FIG. 13. L. S. upper part of anther showing formation of a pollinium by each group of the microspore mother-cells. × 100. FIG. 14. L. S. upper part of flower showing cohered anthers in which there are several pollinia arranged in vertical rows. × 80. FIG. 15. Part of anther showing mature pollinia. Tapetum has become disintegrated. × 100. FIG. 16. L. S. dehisced anther showing breaking of sterile septa, endothecium with characteristic thickenings, epidermis and pollinia to be shed. × 65. FIG. 17. L. S. part of ovary showing thickened cells lining placenta. × 28. FIG. 18. Same as FIG. 17 but enlarged, showing thickened cells and their relation with funicula of ovules. × 80.

is formed by two tetrahedral tetrads, its shape is spherical; 4 grains are at the periphery and 4 in the center in 2 superposed groups of 2 each. The grains at the periphery are conjoint and polyhedral and those at the center polyhedral. Sometimes, the 8-celled pollinium is made up of two isobilateral tetrads (Pl. 1, Fig. 7). In such a case, 4 grains are at the periphery and 4 in the center which are arranged in a row. When the pollinium is 16-celled, it is formed by 4 tetrahedral groups, each occupying a quarter in a sphere (Fig. 6). In each quarter, 2 grains are at the periphery and they are conjoint and polyhedral. The 2 grains which are at the center are superposed. The whole central group thus consists of 8 cells arranged in two superposed groups of 4 each and presents a square in outline.

It is interesting to note that the grains in a pollinium are not held together firmly. A slight disturbance causes the grains to separate from one another and in such cases, one may assume that the plant forms simple pollen-grains. This is probably due to gaps which occur between cells of the peripheral row causing breaking of the tetrad. It is interesting that the Mimosaceae include plants like *Neptunia oleracea* (Singh and Shivapuri, 1935), *Leucaena glauca* (Dnyansagar, 1949), *Neptunia triquetra* (Dnyansagar, 1952), *Prosopis spicigera* and *Desmanthus virgatus* (Dnyansagar, 1953), in which simple grains are formed. In such cases, the microspore mother-cells become rounded after separation from each other and then simple pollen-grains are formed after undergoing two reduction divisions and subsequent separation of the microspores of the tetrads from each other. On the other hand, in plants like *Albizzia lebbek* (Maheshwari, 1931), *Acacia Baileyana* (Newman, 1933, 34), *Acacia farnesiana* (Narasimhachar, 1948) and *Pithecolobium saman* (Dnyansagar, 1951), the microspore mother-cells remain packed together and the entire mass of grains formed after reduction divisions constitutes a pollinium in each lobe of the anther. In *Mimosa hamata* (Dnyansagar, 1951), a very large number of microspore mother-cells is produced in each microsporangium and the whole mass without separation of cells undergoes reduction divisions resulting in the formation of microspores. These grains aggregate in groups of 4–8 and form compound grains. A somewhat similar condition has been described by Narasimhachar in *Mimosa pudica* (1951) where microspores of a quartet do not separate and are shed as a single unit.

In *Parkia biglandulosa*, the pollinium consists of 16 grains which are arranged in the same way as in the case of *Dichrostachys cinerea* (Pl. 2, Figs. 15 and 16).

The individual grain of *Dichrostachys cinerea* is 20-25 μ. (Fig. 7) and that of *Parkia biglandulosa* 30–40 μ in diameter (Fig. 13). The exine on the exposed surface is thicker while on the inner sides it is thin allowing the grain to be shaped suitably by the pressure against the neighboring cells. In *Dichrostachys cinerea*, the exposed surface of the exine shows ridges and furrows. Each grain possesses 3 germ pores (Fig. 7).

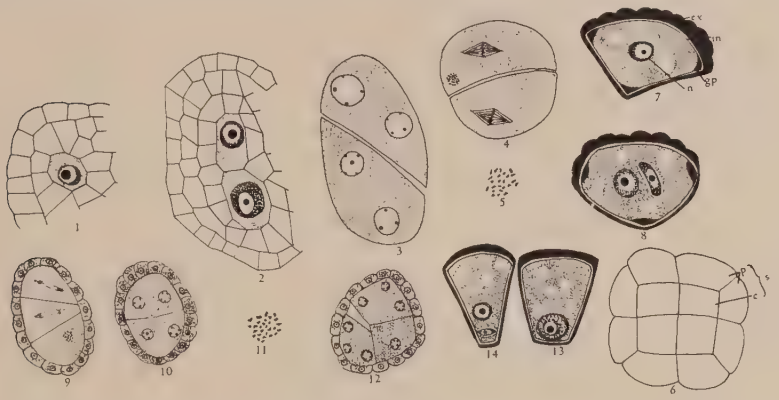
The whole unit of the pollinium is shed as such, the individual grain being bi-celled at the time of its shedding (Figs. 8 and 14).

CHROMOSOME NUMBER

Chromosome number was determined from polar views of the metaphase in the first reduction division of microspore mother-cells. The n-chromosome number determined for *Dichrostachys cinerea* is 24 (Fig. 5) and that for *Parkia biglandulosa* 28 (Fig. 11).

MEGASPOROGENESIS

The ovary bears 8–15 ovules in *Dichrostachys cinerea* and 10–20 in *Parkia biglandulosa* on the ventral suture in two alternating rows. The ovules first appear as small papillae when the microspore mother-



FIGS. 1–8. *Dichrostachys cinerea*—FIG. 1. T. S. lobe of the anther showing differentiated sporogenous cell. FIG. 2. L. S. part of the anther showing two microspore mother-cells and two layers of parietal tissue. FIG. 3. Showing organization of two nuclei in each microspore mother-cell after first meiotic division. FIG. 4. Showing metaphase spindles in microspore mother-cells during second meiotic division. FIG. 5. Metaphase, first meiotic division, showing 24 chromosomes. FIG. 6. Surface view of 16-celled pollinium showing 8 peripheral and 8 central grains, the latter being in 2 superposed groups of 4 each. The pollinium consists of 4 sectors, each sector, *s* being made up of 2 peripheral, *p* and 2 central, *c* grains. FIG. 7. Individual uninucleate pollen-grain showing exine, *ex*, intine, *in*, 3 germ pores, *gp*, and nucleus, *n*. FIG. 8. Individual bi-celled pollen-grain at the time of shedding.

FIGS. 9–14. *Parkia biglandulosa*—FIG. 9. A group of 4 microspore mother-cells surrounded by tapetum and showing first meiotic division. FIG. 10. Show-organization of 2 nuclei in each microspore mother-cell after first meiotic division. FIG. 11. Metaphase, first meiotic division, showing 28 chromosomes. FIG. 12. 3 microspore mother-cells surrounded by tapetum just after second reduction division. FIG. 13. Individual uninucleate pollen-grain. FIG. 14. Bi-celled pollen-grain at the time of shedding. FIGS. 1–5, 7–8, 11 and 13–14, × 360. 6, 9, 10 and 12, × 160.

cells are already formed. They are at first orthotropous, but gradually assume an anatropous position after acutely turning upwards, a condition common in a number of leguminous species including the investigated species of Mimosaceae.

An interesting feature about the nutrition of ovules in *Parkia biglandulosa* is that thick walled polyhedral cells (Pl. 2, Figs. 17 and 18) are formed along the placentae. These cells are larger than the

placental cells and contain larger nuclei embedded in dense cytoplasm suggesting nutritive function.

The nucellus is very massive from the very beginning, a feature which seems to be characteristic of the Mimosaceae.

The primordia of the integuments appear after differentiation of archesporium in the nucellus (Fig. 16). A similar condition has been reported in all of the investigated species of the family. The inner integument develops first and the outer immediately follows it. Both are bi-layered in the beginning. In *Parkia biglandulosa*, both integuments develop more or less at the same time but it is the inner integument that forms the micropyle (Figs. 24 and 25). The inner integument is about 4–5 cells thick at the top. In *Albizzia lebbek* (Maheshwari, 1931), *Neptunia oleracea* (Singh and Shivapuri, 1935), *Leucaena glauca* (Dnyansagar, 1949), *Pithecolobium saman* (Dnyansagar, 1951), *Mimosa pudica* (Narasimhachar, 1951), *Neptunia triquetra* (Dnyansagar, 1952), *Desmanthus virgatus* and *Prosopis spicigera* (Dnyansagar, 1953), all belonging to the Mimosaceae, the outer integument alone forms the micropyle. In *Acacia Baileyana* (Newman, 1934) of the Mimosaceae and *Cassia* of the Caesalpiniaceae (Pantulu, 1945), the micropyle is formed by both integuments. In *Dichrostachys cinerea*, however, the outer integument alone forms the micropyle (Fig. 19) and, when the seed is mature, the inner integument covers only about one third of the nucellus. Both integuments are bi-layered. In one case, though the egg-apparatus was formed, the integuments did not even reach the level of the nucellus and, in this way, the formation of the micropyle was delayed. In *Acacia Baileyana* (Newman, 1934), the nucellus is naked and it is only after fertilization that the integuments develop and subsequently the outer one forms the micropyle.

In later stages, the cells of the outer-side of the outer integument in *Parkia biglandulosa* become filled with golden brown contents. A similar condition has been reported in *Neptunia oleracea* (Singh and Shivapuri, 1935).

The archesporium is hypodermal and single celled. It cuts off a parietal cell by a periclinal wall (Figs. 15 and 21). The perietal cell

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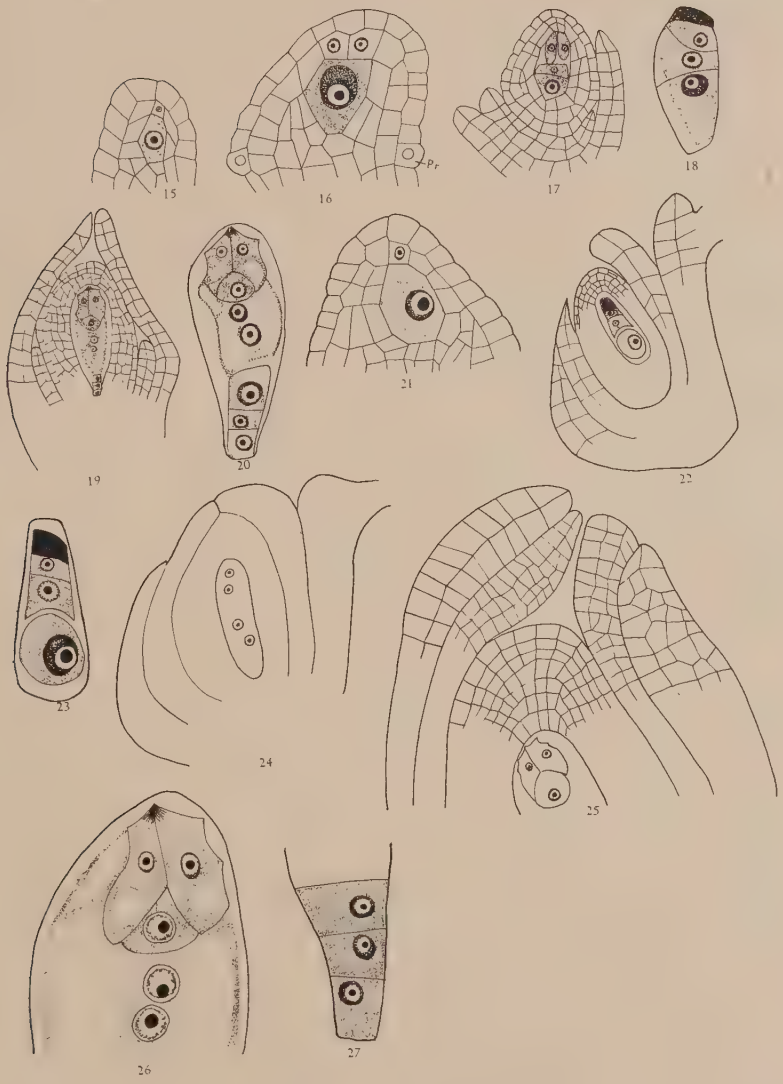
EXPLANATION OF TEXT FIGURES

FIGS. 15–20. *Dichrostachys cinerea*—FIG. 15. L. S. nucellus showing parietal cell and megaspore mother-cell. FIG. 16. L. S. nucellus showing parietal layer of 2 cells, megaspore mother-cell and primordium of inner integument, *pr*. FIG. 17. L. S. ovule showing T—shaped tetrad of megaspores and 2 integuments. FIG. 18. Linear tetrad of megaspores, of which the uppermost is degenerating. FIG. 19. L. S. ovule at the mature embryo-sac stage, showing formation of micropyle by outer integument alone and epidermal cap. FIG. 20. Mature embryo-sac. FIGS. 21–27. *Parkia biglandulosa*—FIG. 21. L. S. nucellus showing parietal cell and megaspore mother-cell. FIG. 22. L. S. ovule showing linear tetrad of megaspores, formation of epidermal cap and 2 integuments. FIG. 23. Linear tetrad of megaspores, of which the uppermost is degenerating. FIG. 24. L. S. ovule showing 4 nuclei in the embryo-sac and inner integument covering the nucellar apex. FIG. 25. L. S. upper part of ovule at the mature embryo-sac stage showing epidermal cap and formation of micropyle by inner integument alone. FIG. 26. Micropylar part of embryo-sac showing egg-apparatus and 2 polar nuclei. FIG. 27. Chalazal part of embryo-sac showing 3 antipodal cells. FIGS. 15–16, 18, 20–21, 23, 26–27, × 400; FIGS. 17, 19, 22, 24–25, × 180.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by its activity forms the extensive parietal tissue which appears to be a characteristic feature of the Caesalpiniaceae and the Mimosaceae.

The megaspore mother-cell first enlarges and then undegoes two reduction divisions to give rise to a linear tetrad of megaspores (Figs. 18 and 23). In *Dichrostachys cinerea*, a T-shaped tetrad was observed in one case (Fig. 17). A similar condition has been reported in *Leucaena glauca* (Dnyansagar, 1949) and *Prosopis spicigera* (Dnyansagar, 1953).

The chalazal megaspore becomes functional and the remaining megaspores disintegrate. It then enlarges and forms the 8-nucleated Normal or Polygonum type of embryo-sac (Figs. 20, 26 and 27).

The embryo-sac enlarges at the cost of the parietal tissue and rests against the epidermal cap at the micropylar end (Figs. 19 and 25). The starch-grains appear in the sac from the 8-nucleated stage onward. These plants are additions to the list of the plants of the Leguminosae in which starch-grains appear in the embryo-sac (Dahlgren, 1939, Dnyansagar, 1951 a&b, and 1952).

The egg-apparatus consists of two synergids and the egg (Figs. 20 and 26). The synergids are hooked and each has a filiform apparatus. The hooked synergids have been observed in several species of the Leguminosae including *Albizzia lebbek* (Maheshwari, 1931), *Acacia Baileyana* (Newman, 1933, 34), *Neptunia oleracea* (Singh and Shivapuri, 1935), *Acacia farnesiana* (Narasimhachar, 1948), *Leucaena glauca* (Dnyansagar, 1949), *Mimosa hamata* (Dnyansagar, 1951), *Pithecolobium saman* (Dnyansagar, 1951), *Neptunia triquetra* (Dnyansagar, 1952), *Prosopis spicigera* and *Desmanthus virgatus* (Dnyansagar, 1953) of the Mimosaceae. The antipodals form definite cells (Figs. 20 and 27) as in previously investigated species of the Leguminosae.

The two polar nuclei lie either in the middle of the sac or toward the egg.

SUMMARY

1. The inflorescence of *Dichrostachys cinerea* is an axillary spike bearing polygamous flowers. The lower region bears the sterile flowers, the upper fertile and bisexual ones and the small middle region the flowers showing an intermediate condition. In *Parkia biglandulosa*, the inflorescence is a drooping head.

2. The floral parts arise in acropetal succession and are cyclic in their arrangement.

3. In *Dichrostachys cinerea*, the parietal tissue is composed of the endothecium, one or two middle layers and a tapetal layer in each anther-lobe. Occasionally, a transverse septum of tapetal cells is formed as a result of which the sporogenous mass of cells in each lobe becomes partitioned into two compartments. A sterile transverse septum consisting of cells from the middle layer was observed in one case and a tapetal layer developed on both sides of this septum.

Each anther-lobe shows 2–4 vertical rows of 6–12 microspore mother-cells which later on become arranged in groups of 2–4 in each vertical row. Ultimately from each group, there develops a pollinium, the number of cells composing it varying from 8–16.

4. In *Parkia biglandulosa*, the number of sporogenous cells in each anther lobe varies from 10–20 and these are arranged in a char-

acteristically vertical row. Transverse sterile septa appear between consecutive sporogenous cells so that each compartment contains only one sporogenous cell. This cell after undergoing two mitotic divisions forms a group of four microspore mother-cells which ultimately give rise to a pollinium of 16 grains. There are thus formed 10–20 pollinia in each anther-lobe arranged in a vertical row. Each pollinium is nourished by its own tapetum.

The definition of the sporangium is discussed.

5. The tapetum in both species is of the secretory type and its cells remain uninucleate throughout.

6. The grains in the pollinium of *Dichrostachys cinerea* are not firmly held together.

Pollinia are shed as such and individual pollen-grains are bi-celled at the time of shedding.

7. The ovules are anatropous and have two integuments. The outer integument alone forms the micropyle in *Dichrostachys cinerea* while in *Parkia biglandulosa*, it is formed by the inner integument.

8. Megasporogenesis occurs in the normal way. A single hypodermal archesporial cell appears in the massive nucellus and cuts off a primary parietal cell. The latter and also the epidermal cells undergo several divisions to form an extensive parietal tissue and an epidermal cap respectively. A linear tetrad of megaspores is formed, of which the chalazal functions. A T-shaped tetrad was also observed in one case in *Dichrostachys cinerea*.

9. The embryo-sac is of the 8-nucleated Normal or Polygonum type. The synergids are hooked and each has a filiform apparatus. The antipodals form definite cells. Starch-grains appear in the mature sac.

ACKNOWLEDGEMENTS

The author expresses his grateful thanks to Prof. R. L. Nirula for guidance and to Prof. J. Venkateswarlu and Dr. K. Subramanyam for the material of *Dichrostachys cinerea*.

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The Cladoniaceae of Virginia

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The Cladoniaceae constitute the most conspicuous element of the Virginia lichen flora, perhaps half of the lichens found in most localities throughout the state belonging to this group. Although they are of little economic importance, they are of considerable popular and botanical interest; and a description of the family as it occurs in this state seems, therefore, to be desirable. The present report contains a list of species of Cladoniaceae found in Virginia together with keys and illustrations to assist in their identification. It is based upon collections made for the most part during 1941 and 1942, although a few collections were made as early as 1935 and a few as late as 1944. These specimens have been deposited in the herbarium of the University of Richmond, and duplicates of all specimens have been placed in the Osborn Botanical Laboratory of Yale University. A representative series of specimens has been placed in the Farlow Herbarium of Harvard University. Since citations of specimens have been omitted, the original manuscript containing complete lists of the collections on which this study is based has been deposited in the Lloyd Library. Determinations of *Cladonia* species have been based on Evans' publications on the genus (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15). All figures are natural size photographs. The collection number of each of the specimens from which the illustrations were made is indicated in the legends accompanying the figures.

Although this is the first attempt at a state flora of the Cladoniaceae for Virginia, papers on the *Cladoniae* of restricted areas in the state have been published previously. The report of Robbins and Blake (19) on the *Cladoniae* of the District of Columbia included adjacent regions of Virginia. More recently Allard and Leonard (1) have made an intensive study of the *Cladoniae* of Bull Run Mountain.

Cladoniaceae

Members of the Cladoniaceae are easily recognized because of the twofold nature of the plant body. This is composed of a primary thallus and podetia. The primary thallus may be crustose, covering the substrate as a thin, gray, smooth to warty film (Fig. 1, 3, 4), or

[1]I am indebted to Dr. Ivey F. Lewis for making available to me the facilities of the University of Virginia and of the Mountain Lake Biological Station, to Dr. Robert F. Smart for providing herbarium and laboratory facilities at the University of Richmond, to Dr. J. C. Strickland, Dr. L. C. Goldstein, and Dr. W. T. Allman for assistance in making the collections, and to Dr. J. C. Strickland for furnishing his personal collections and for his suggestions. I am especially grateful to Dr. Alexander W. Evans whose kindness in checking my determinations of all specimens of Cladoniae has made this study possible.

foliose in which case it is divided into numerous small, leaf-like plates called squamules (Fig. 9, 10). In some species tiny spherical masses of fungus hyphae enclosing a few algal cells are formed over the surface or along the margins of the squamules. These are termed soredia. If the soredia are very small so that the individual grains are hardly distinguishable under the hand lens and appear as a find powder, they are described as farinose. Larger soredia are described as granular. The podetia grow upward as erect, fruticose, cylindrical branches from the squamules (Fig. 84, 88) or the crustose thallus (Fig. 4, 7). In two genera, *Baeomyces* and *Stereocaulon*, the podetia are solid; in the third genus, *Cladonia*, they are hollow. The podetia may be short and unbranched (Fig. 1, 70, 85) or with short branches at the tips (Fig. 59, 60, 88) or long and variously branched (Fig. 11, 22, 25). In some species perforations through the wall of the podetium are formed in the axils of the branches (Fig. 12, 23). Branching may be dichotomous (Fig. 15, 24) or polytomous (Fig. 12, 23). In the latter type branches arise in whorls of three or more branches surrounding a perforation in the podetial wall. In either type one branch may grow more rapidly than the others to form a single main axis or sympodium (Fig. 13). The podetia may be fairly uniform in diameter (Fig. 11, 25), but often they are expanded to form cup-like structures at the tips (Fig. 36, 55, 71). The cups may be closed (Fig. 36) or open into the central cavity of the podetium by a perforation. Often the cups develop special branches, or proliferations, from the centers (Fig. 45–49) or margins (Fig. 38, 50), and the proliferations may in turn form cups, giving rise to a series of cups (Fig. 45, 50).

The podetial wall is composed of three layers: (1) an inner layer of closely compacted fungus hyphae having a cartilaginous appearance, the inner medulla, (2) a layer of loosely interwoven hyphae in which the algal cells are enmeshed, the outer medulla, and (3) an outer layer of compacted fungus hyphae, the cortex. The cortex may be lacking. Then the loose outer medulla may give the surface of the podetium a cottony, or arachnoid, appearance, or the peripheral hyphae of the outer medulla may become compacted to form a smooth pseudocortex. The cortex (or pseudocortex) may form a continous surface or may be fissured and divided into small plates, or areolae. Squamules similar to the primary squamules may be present (podetia squamulose Fig. 28, 35) or absent (podetia esquamulose Fig. 11, 25) on the podetia. Often the cortex and outer medulla are lacking over all or part of the podetial surface (podetium ecorticate), exposing the cartilaginous inner medulla may be white and apaque or translucent and darkened. soredia (podetia sorediose) or bare (podetia esorediose). The naked inner medulla may be white and opaque or translucent and darkened. In a few species the cartilaginous inner medulla may be lacking or broken up into a network of distinct strands.

The fungus fruiting bodies, the apothecia, are borne at the tips of the podetia (Fig. 59, 60, 85). The disc of the apothecium is generally strongly convex so that the apothecium becomes almost spherical. It is colored either red or brown, although there are forms of some species in which it is flesh-colored or yellowish. In some species apothecia are almost always present. In others they are rarely found.

FIG. 1–10.—Cladoniaceae of Virginia. FIG. 1.—*Baeomyces roseus* No. 105. FIG. 2.—*Stereocaulon coralloides* No. 3317. FIG. 3. *Cladonia papillaria* f. *papillosa* No. 1512. FIG. 4. *Cladonia papillaria* f. *moliformis* No. 4883. FIG. 5. *Cladonia papillaria* f. *stipata* No. 3937. FIG. 6 *Cladonia papillaria* f. *molariformis* No. 1531. FIG. 7. *Cladonia papillaria* f. *molariformis* No. 2022. FIG. 8. *Cladonia papillaria* f. *molariformis* No. 3038. FIG. 9. *Cladonia apodocarpa* No. 3269. FIG. 10. *Cladonia robbinsii* No. 2469.

Sometimes the two-fold nature of the plant body is not evident. In species such as *Cladonia rangiferina* (Fig. 11, 12), *C. sylvatica* (Fig. 13), *C. subtenuis* (Fig. 14–17), *C. caroliniana* (Fig. 18–20), and *C. uncialis* (Fig. 21–23) the primary thallus is evanescent and is rarely seen. These are all large fruticose species growing on soil and are easily recognized as members of the Cladoniaceae. In *C. apodocarpa*, on the other hand, the podetia are lacking, and the apothecia, if present are sessile on the primary squamules. The squamulose primary thallus of this species (Fig. 9) is sufficient, however, to show its affinity with the Cladoniaceae.

Genus 1. Baeomyces Ehrh.

1. Baeomyces roseus Pers. (Fig. 1)

This is the only species of the genus collected in Virginia. It is, however, very common throughout the state and is easily recognized. The greenish-gray, crustose primary thallus often covers large areas of soil in old fields and open woods and along roadside banks. The podetia are stout, whitish, club-shaped stipes, each bearing a single large, globose, pink or flesh-colored apothecium at the tip.

Genus 2. Stereocaulon (Schreb.) Hoffm.

1. Stereocaulon coralloides Fr. (Fig. 2).

This species is the only representative of the genus found in Virginia. It has been collected once at an elevation of 4000 feet in the Blue Ridge Mountains (Hawksbill Mt.). It grew on the granitic rock of a cliff ledge. The primary thallus was lacking. The podetia (pseudopodetia) formed low, dense mats and were long, sprawling, dichotomously branched, and ecorticate. On the side toward the interior of the mat they were naked and whitish or darkened to tan or brown. On the exposed side at the periphery of the mat they were densely covered with coralloid squamules and granules.

Genus 3. Cladonia (Hill) Web.

Aside from differences in color and size of the apothecia, there is little variation among the *Cladoniae* in characteristics of the ascospores and associated organs of sexual reproduction, the structures which generally furnish the basic taxonomic criteria for the classification of other groups of Ascomycetes. Consequently, the species of *Cladonia* are classified primarily on the basis of vegetative characters such as type of primary thallus, size and type of branching of the podetia, presence or absence of cups, structure of the podetial wall, presence or absence of soredia on the primary thallus and podetia, type of soredia, presence or absence of squamules on the podetia, and color of the thallus. As might be expected, such characters are highly variable; and as a consequence, the genus has been split into numerous species. Even these restricted species, however, are capable of great variation as is attested by the number of varieties, forms, and modifications described under most of the species. The species intergrade to such an extent that species limits are difficult to define, and borderline specimens are often found that can hardly be determined to species. There has

FIG. 11–17.—Cladoniaceae of Virginia. FIG. 11. *Cladonia rangiferina* No. 3425. FIG. 12. *Cladonia rangiferina* f. *crispata* No. 3241. FIG. 13. *Cladonia sylvatica* No. 2174. FIG. 14. *Cladonia tenuis* No. 1651. FIG. 15–16. *Cladonia tenuis* No. 1513 (fruiting). FIG. 17. *Cladonia tenuis* No. 1647.

been, therefore, in recent years a general application of methods of microchemical analysis in the determination of species. These methods are based on the fact that *Cladonia* species produce characteristic lichen acids which may be determined by color reactions with standard reagents or by crystal structure when they are extracted and crystalized (10). These tests have proved to be of value in the definition and determination of species when they can be correlated with morphological variations. Continued investigations, however, have disclosed differences in lichen acids present in *Cladoniae* that are morphologically similar. This has led to the description of many new species based solely on differences in the lichen acids present and to a transference of emphasis in the definition of species from morphological to chemical characteristics. An exceedingly complex system of classification has resulted. It is probable that a critical examination and re-evaluation of the criteria employed in the classification of the *Cladoniae* will, as indicated by Weise (21), afford a sounder basis for the classification of the genus. Experimental studies such as those of Weise (21) may lead to the recognition of many of the named species as mere growth forms of a few valid species of fungi and result in a tremendous reduction in the number of species of *Cladonia*. At present, however, sufficient data are not available for the fundamental reorganization of the genus which appears to be necessary. Lamb's (18) proposal that morphologically indistinguishable individuals which contain distinct lichen acids be designated simply as chemical strains of a single species seems to be the most satisfactory system of classifying chemical variants and should be taken into consideration in any revision of the *Cladoniae*.

Despite personal doubts as to the validity of numerous species, the classification of the *Cladoniae* in this report follows the complex system which has been generally accepted in the United States (1, 2, 17, 20) in place of the somewhat more conservative treatment of Fink (16) as a result of Evans' thorough and extensive work on the genus. In the following key to species of *Cladonia* the separation of species has been based primarily on morphological characters. Chemical tests have been employed generally as an aid in making determinations and at many points, of necessity, as the primary or only basis for distinguishing species. In making the chemical tests with potassium hydroxide or paraphenylenediamine a piece of dry podetium or primary squamule is placed on a glass slide and moistened with a drop of a ten percent solution of potassium hydroxide in water or a one percent solution of paraphenylenediamine in 95 percent ethyl alcohol. The reaction depends upon the species tested. No visible reaction may take place or, on standing, the treated thallus and surrounding solution may turn various shades of red, yellow, or brown. In the key the reactions to these tests are indicated as follows: With potassium hydroxide K— indicates no reaction; K + red, K + yellow, etc., indicate a reaction and the color produced. With paraphenylenediamine P — indicates no reaction, P + red, P + yellow, etc., indicate a reaction and the color produced. For a full description of methods of microchemical analysis Evans' (10) review of microchemical studies should be consulted.

KEY TO SPECIES OF CLADONIA

1. Primary thallus crustose, persistent. Podetia gray, scattered or crowded on the gray primary thallus; simple, tubular outgrowths; or irregularly expanded with short branches at the tips; or cylindrical and branching at the tips to form dense clusters of cylindrical branches; when immature, small, globular, brown-tipped outgrowths. Apothecia small, reddish-brown, clustered at the tips of the podetia, often lacking..... *C. papillaria*
1. Primary thallus squamulose or evanscent and then usually lacking (rarely crustose, but then evanescent)..... 2
2. Primary thallus evanescent, almost never present. Podetia long, repeatedly branched and interwoven to form large, mound-shaped colonies, disintegrating toward the base..... 3
2. Primary thallus persistent, squamulose..... 11
3. Podetia with a conspicuous, well-developed cortex. (In cross-sections under the microscope the cortex is evident as a peripheral layer of compacted, hyaline hyphae completely covering the medullary layer of loosely interwoven hyphae in which the algal cells are enmeshed). Colonies loose, irregular. Primary thallus squamulose but usually evanscent.... 4
3. Podetia lacking a true cortex. (In cross-sections under the microscope the medulla, containing algal cells, is seen to form the outer layer); cylindrical, slender, uniform in diameter except for small branchlets at the tips which are usually curved and flaccid, surface often arachnoid (cobwebby rather than smooth). Colonies regular, compact. Apothecia small, brown, usually lacking. Primary thallus crustose, usually evanescent..... 7
4. Podetial cortex deeply wrinkled, especially toward the base, bright yellowish-green. Apothecia bright red, usually present. K −; P + yellow. *C. leporina*
4. Podetial cortex smooth or slightly warty. Apothecia brown, often lacking.. 5
5. Podetia slender, uniform in diameter, usually erect, with gaping openings in the branch axils, grayish-green to brownish; often squamulose, especially toward the base. Squamulose primary thallus often persistent. K − or K + faint yellow to brown; P + red..... *C. furcata*
5. Podetia often irregularly inflated and sometimes expanded at the tips to form crude cup-like structures; usually sprawling; branch axils closed or with small round openings; ultimate branchlets smaller in diameter, stiff, straight, spinose; often with short spinose outgrowths along the sides of the podetia. Squamulose primary thallus usually evanescent. K −; P −.. 6
6. Branch axils of podetia, at least in part, perforated. Podetia sometimes with perforated cups surrounded by spinose branchlets at the tips. Podetial cortex shiny, yellowish- to brownish-green. Cartilaginous layer of inner medulla continuous. (In cross-sections under the microscope it appears as a layer of compacted, hyaline hyphae completely surrounding the central cavity. When the inner surface of a split podetium is examined under the hand lens, it appears smooth)..... *C. uncialis*
6. Branch axils of podetia usually closed. Podetial cortex dull, yellowish-green. Cartilaginous layer of inner medulla divided into distinct strands. (In cross-sections under the microscope the loose medulla containing algal cells is seen to abut on the central cavity except where strands of the compact cartilaginous layer cross its surface. When the inner surface of a split podetium is examined under the hand lens, the strands appear as a faint network over the surface)..... *C. caroliniana*
7. Podetia ashy-gray, dichotomously or usually polytomously branched; branch axils perforated; rarely fruiting. K + yellow; P + red.. *C. rangiferina*
7. Podetia yellowish-green..... 8
8. Podetia mostly dichotomously branched; branch axils usually closed; often fruiting. K + yellow; P + red..... *C. subtenuis*
8. Podetia mostly polytomously branched; branch axils perforated; rarely fruiting. K −; P − or P + red..... 9
9. P + red..... *C. sylvatica*
9. P −..... 10
10. Ultimate branchlets of the podetia in twos or threes, relatively long and slender and usually curved. Containing usnic acid alone or accompanied by substances A, B, or D, singly or in various combinations. (see Evans, 11) ..... *C. mitis*

10. Ultimate branchlets of the podetia more numerous and shorter, curvature tending to be less pronounced; podetia more robust. Containing usnic acid and substance C, sometimes accompanied by substance A but never B or D. (see Evans, 11)..... *C. submitis*
11. Podetia lacking and apothecia lacking or sessile on the primary squamules; or podetia so short that the apothecia appear to be immersed in the primary squamules. Apothecia brown..... 12
11. Podetia present, well developed, simple or variously branched, cylindrical or expanding to form cups..... 14
12. Primary squamules small, densely clustered, erect, margins minutely cut and toothed. Apothecia always present; large; on short, whitish, translucent stipes which lack cortex and algal cells. (Podetia occasionally better developed, up to 3 mm. long, with a gray, warty cortex.) K −; P + red..... *C. caespiticia*
12. Primary squamules long, strap-shaped, prostrate and ascending at the tips, margins almost smooth. Podetia lacking. Apothecia sessile on the primary squamules, usually lacking..... 13
13. Squamules pale grayish-green on the upper surface, chalky-white on the lower surface; when dry, curling upward to expose the lower surface and extremely brittle. Apothecia rarely present; then sessile on the primary squamules and inconspicuous. K + faint yellow; P + red..... *C. apodocarpa*
13. Squamules dark-green on the upper surface, cream-colored on the lower surface. K −; P − (Typically forming well-developed podetia, but these so commonly not developed that this species is included in the key at this point for convenience in determining sterile specimens)..... *C. robbinsii*
14. Podetia densely clustered to form large matted colonies, long, irregularly branched. Apothecia brown, often lacking..... 15
14. Podetia separate, not forming mat-like colonies..... 17
15. Podetia always corticate, with smooth grayish-green to brownish cortex, cupless, usually with gaping openings in branch axils, often squamulose. K − or K + pale yellow; P + red..... *C. furcata*
15. Podetia with cortex more or less disintegrating and exposing the whitish inner medulla, ashy-gray to grayish green or brownish, usually densely covered with large to minute squamules; branch axils open and tips often expanded to form open funnel-shaped cups which are smooth and brown on the inside. Primary squamules much divided. K-; P- or P + yellow. ..16
16. P −..... *C. squamosa*
16. P + yellow..... *C. atlantica*
17. Podetia forming cups..... 18
17. Podetia not cup-forming..... 36
18. Podetia cylindrical except at the tips where they are slightly expanded to form minute cups. Apothecia brown, often lacking..... 19
18. Podetia gradually expanding from the base upward to form large cups.... 25
19. Cups funnel-shaped openings leading into the central cavity of the podetium, brown on the inside. Podetial cortex more or less disintegrating and exposing the whitish inner medulla. Podetia never sorediose, usually densely covered with large to minute squamules..... 20
19. Cups closed, shallow. Podetia ecorticate and sorediose..... 21
20. K −; P −..... *C. squamosa*
20. K −; P + yellow..... *C. atlantica*
21. Soredia farinose. Podetia short (15 mm. or less); cups merely small depressions in the slightly expanded tips, often lacking and the podetia pointed at the tips. K + brown; P + red..... 22
21. Soredia granular or, if farinose, mixed with numerous granules..... 23
22. Inner surface of cups ecorticate and sorediose. Podetia ecorticate and sorediose except for a small corticate area at the base..... *C. coniocraea*
22. Inner surface of cups corticate; basal corticate area extending part way up the podetia..... *C. ochrochlora*
23. Podetia long (15–40 mm.), ecorticate above, covered with finely granular soredia, cylindrical, expanded at the tips into shallow cups with irregular projections around the margins or pointed and cupless, simple or with short branches at the tips. K −; P − or P + red..... *C. nemoxyna*
23. Podetia short (less than 15 mm.). K −; P + red..... 24

24. Grayanic acid present Podetia ecorticate and covered with farinose soredia mixed with coarse granules..... *C. cylindrica*
24. Grayanic acid lacking. Podetia corticate or ecorticate and covered with coarse granular soredia..... *C. pityrea*
25. Cups flat, shallow, saucer-shaped, usually proliferating several times. Apothecia brown, often lacking..... 26
25. Cups deep funnel- or trumpet-shaped, rarely proliferating and then usually only once. Apothecia brown or red, often lacking..... 29
26. Cups irregular, proliferating from both margins and centers, distorted and often obliterated by numerous branches proliferating from the margins. Podetia short, smoothly corticate, squamulose or esquamulose. *C. mateocyatha*
26. Cups regular, well developed, proliferating from either margins or centers, not from both. Podetia long..... 27
27. Cups proliferating only from margins, with few proliferations..... *C. gracilis*
27. Cups proliferating repeatedly from the centers to form a series of cups. Podetia squamulose or esquamulose, rarely proliferating from the sides of the podetia as well as from the centers of the cups..... 28
28. Cups expanding gradually from the podetia; margins thick, smooth or shallowly toothed. Apothecia, when present, sessile on the margins of the cups ..... *C. verticillata*
28. Cups expanding abruptly from the podetia; margins thin, deeply toothed. Apothecia, when present, on short stipes along margins of the cups..... ..... *C. calycantha*
29. Apothecia red, often lacking. Podetia yellowish-green. K + yellow or, if K −, containing zeorine. (If the characteristic apothecia are lacking, sterile specimens of the two species with funnel-shaped podetia and red apothecia, *C. pleurota* and *C. digitata*, may be difficult to distinguish from sterile specimens of the species with funnel-shaped podetia and brown apothecia. The digitate cups, corticate on the inside and ecorticate and farinose sorediate on the outside, and the K + yellow reaction are sufficient to distinguish *C. digitata*. In order to identify sterile specimens of *C. pleurota* positively it is necessary to demonstrate the presence of the lichen acid zeorine which occurs in this species but is lacking in the others. However, the yellowish tinge of the podetia in *C. pleurota* may be of some assistance)..... 30
29. Apothecia brown, often lacking. Podetia grayish-green, corticate with scattered warty areolae, or ecorticate and farinose to granular sorediose, squamulose or esquamulose. Cups rarely proliferous. K + red or K −; Zeorine lacking..... 31
30. Podetia corticate or ecorticate and with farinose to granular soredia inside and outside of cups; margin of cups smooth or shallowly toothed. K −; P −; zeorine present..... *C. pleurota*
30. Cups with smooth green cortex on inner surface, irregular, with horn-like projections from the margins. Podetia corticate at the base but ecorticate and farinose sorediate toward the tips and over the outer surface of the cups. K + yellow; P + red; Zeorine lacking..... *C. digitata*
31. Podetia corticate, esorediose. K −; P + red..... *C. pyxidata*
31. Podetia more or less ecorticate and sorediose..... 32
32. Soredia farinose..... 33
32. Soredia granular..... 34
33. Cups narrow, trumpet-shaped, sometimes lacking and the tips of the podetia blunt. Podetia whitish. Apothecia almost always lacking. K −; P + red..... *C. fimbriata*
33. Cups broad, funnel-shaped. K + brown; P + red..... *C. conista*
34. Cryptochlorophaeic and grayanic acids lacking. K −; P + red..... ..... *C. chlorophaea*
34. Cryptochlorophaeic or grayanic acid present. K + red or K −; P + red or P −..... 35
35. Grayanic acid present. K −, P + red or P −..... *C. grayii*
35. Cryptochlorophaeic acid present. K + red, P + red or P −..... ..... *C. cryptochlorophaea*
36. Apothecia present..... 37
36. Apothecia lacking..... 61
37. Apothecia red..... 38

37. Apothecia brown 45
38. Plants yellowish-green 39
38. Plants greenish-gray or whitish 40
39. Primary squamules densely clustered, densely farinose sorediate and often passing into a sorediose crust. Podetia corticate or ecorticate and sorediose. Apothecia bright red ..... *C. incrassata*
39. Primary squamules not sorediose. Podetia always corticate, esorediose, simple or with short branches toward the apex, squamulose or esquamulose. Apothecia dull red ..... *C. cristatella*
40. Podetia ecorticate, covered with coarse granules and squamules, these falling away to expose the pellucid, brownish cartilaginous layer 41
40. Podetia corticate or usually ecorticate and covered with farinose (rarely granular) soredia; ecorticate areas white, opaque 42
41. K + yellow; P + red ..... *C. vulcanica*
41. K −; P − or P + pale yellow ..... *C. didyma*
42. K + yellow; P + red. Podetia often corticate 43
42. K −; P −. Always ecorticate and farinose sorediate 44
43. Primary squamules minute, wart-like, often breaking down into a granulose crust. Podetia corticate; cortex thick, warty ..... *C. ravenelii*
43. Primary squamules leafy. Podetia ecorticate and farinose (rarely granular) sorediate or rarely corticate ..... *C. macilenta*
44. Podetia usually corticate basally but wholly ecorticate and farinose sorediate above the base ..... *C. bacillaris*
44. Podetia more or less corticate throughout their entire length, at least with corticate patches in the farinose sorediate upper part, often entirely ecorticate in the upper portions except for a narrow corticate ring below the apothecium ..... *C. floerkeana*
45. Primary squamules with large granules along the margins, forming a dense granulose crust. Podetia more or less corticate, granulose sorediate, delicate ..... *C. delicata*
45. Primary squamules not forming a granulose crust 46
46. Branch axils perforated 47
46. Branch axils closed 51
47. Podetia corticate 48
47. Podetia more or less ecorticate 49
48. Podetia long, much branched, openings in branch axils gaping ..... *C. furcata*
48. Podetia short, little branched, openings in branch axils small round perforations ..... *C. floridana*
49. Podetia covered with farinose soredia ..... *C. farinacea*
49. Podetia esorediose, usually densely squamulose 50
50. K −; P − ..... *C. squamosa*
50. K −; P + yellow ..... *C. atlantica*
51. Podetia ecorticate, sorediose 52
51. Podetia corticate, esorediose 55
52. Soredia farinose 53
52. Soredia granular or, if farinose, mixed with large granules 54
53. Podetia ecorticate and sorediose except for small corticate areas at the base. ..... *C. coniocraea*
53. Basal corticate area extending part way up the podetium ..... *C. ochrochlora*
54. Grayanic acid present. Soredia farinose, mixed with granules. Ecorticate areas of podetia white, opaque ..... *C. cylindrica*
54. Grayanic acid lacking. Soredia granular. Ecorticate areas of podetia pellucid, dark ..... *C. pityrea*
55. Primary squamules small (less than 1 mm. long) 56
55. Primary squamules large 57
56. Plants grayish-green. Podetia simple or sparingly branched at the tips, with a withered, furrowed appearance as if they had been twisted, rarely squamulose. Apothecia large, over twice the diameter of the podetia, dark brown (pallid in one form). K + faint yellow; P + red ..... *C. capitata*
56. Plants yellowish-green. Podetia larger, often with short branches toward the apex, cortex smooth or areolate, often squamulose, usually expanded and club-shaped below the apothecia and almost as broad as the apothecia. Apothecia large, pale tan with lavender tints. K −; P − ... *C. piedmontensis*

57. Podetia and squamules green with a brassy-yellowish tinge. Podetia much branched, often covered with squamules, forming dense coralloid masses. Apothecia brown with a purplish tinge. Lichen acid strepsilin present ..... *C. strepsilis*
57. Podetia grayish-green, simple or sparingly branched toward the tips, squamulose or esquamulose. Apothecia dark brown. Strepsilin lacking.. 58
58. K − 59
58. K + red or yellow 60
59. P + red ..... *C. clavulifera*
59. P + yellow ..... *C. brevis*
60. K + red; P + yellow to orange ..... *C. subcariosa*
60. K + yellow; P + yellow to orange-red ..... *C. polycarpia*
61. Podetia short, simple, stipe-like, rarely branched toward the tips, if branched, branch axils closed 62
61. Podetia long, branched, branch axils perforated 71
62. K — and P − or P + pale yellow or K + yellow and P + red 63
62. K + faint brown; P + red 68
63. Podetia ecorticate and covered with coarse granules which fall away to expose the pellucid, brownish, cartilagenous inner medulla 64
63. Podetia corticate or ecorticate and covered with farinose (rarely granular) soredia, ecorticate areas white, opaque 65
64. K −; P − or P + pale yellow ..... *C. didyma*
64. K + yellow; P + red ..... *C. vulcanica*
65. K + yellow; P + red. Podetia often corticate 66
65. K −; P −. Podetia ecorticate and farinose sorediate 67
66. Primary squamules minute, wart-like, often breaking down into a granulose crust. Podetia corticate; cortex thick, composed of wart-like areolae ..... *C. ravenelii*
66. Primary squamules leafy. Podetia ecorticate and farinose (rarely granular sorediate), rarely corticate ..... *C. macilenta*
67. Podetia usually corticate basally but wholly ecorticate and farinose soredi ate above the base ..... *C. bacillaris*
67. Podetia more or less corticate throughout their entire length, at least with corticate patches in the farinose sorediate area in the upper part.. *C. floerkeana*
68. Podetia ecorticate, covered with farinose soredia 69
68. Podetia ecorticate; soredia granular or, if farinose, mixed with coarse granules 70
69. Podetia ecorticate and sorediose except for a small corticate area at the base ..... *C. coniocraea*
69. Corticate area extending part way up the podetium ..... *C. ochrochlora*
70. Grayanic acid present. Podetia covered with farinose soredia and coarse granules; ecorticate areas white, opaque ..... *C. cylindrica*
70. Grayanic acid lacking. Soredia granular; ecorticate areas of podetia pellucid, dark ..... *C. pityrea*
71. Podetia corticate 72
71. Podetia more or less ecorticate 73
72. Podetia much branched, with gaping openings in the branch axils. K—; P + red ..... *C. furcata*
72. Podetia little branched, with small, round perforations in the branch axils. K + yellow; P + red ..... *C. floridana*
73. Podetia covered with farinose soredia. K −; P + red ..... *C. farinacea*
73. Podetia esorediose 74
74. K −; P − ..... *C. squamosa*
74. K −; P + yellow ..... *C. atlantica*

Subgenus 1. CLADINA (Nyl.) Vainio

1. CLADONIA RANGIFERINA (I) Web. (FIG. 11, 12).

A characteristic species of the western mountainous region of the state where it occurs commonly on soil and over mosses along roadside banks, on cliff ledges, and in open woods, shale barrens, and heath balds; rarely extending into the Piedmont. Distinguished from the

following species in the subgenus Cladina by the ashy gray color of the podetia which typically contrasts sharply with the stramineous or yellowish tinge of the podetia in the other species.

Cladonia rangiferina f. *crispata* Coem.

A form in which the podetia are more densely branched and the colonies more compact than in typical specimens of the species. Compare the illustration of this form (Fig. 12) with that of a typical representative of *C. rangiferina* (Fig. 11).

2. CLADONIA SYLVATICA (L.) Hoffm. (FIG. 13).

Also a characteristic species of the flora of the western mountainous region, found in the same habitats as, and often in association with, *C. rangiferina*, encountered more commonly than the latter in the Piedmont where it extends eastward to the Fall Line.

Of the following species *C. subtenuis* typically is distinct from *C. sylvatica* in that the podetia are slenderer and predominantly dichotomously rather than polytomously branched. However, in the mountains, where they occur together, *C. subtenuis* often is more robust and intergrades with *C. sylvatica* to such an extent that it is sometimes difficult to distinguish the two. Certainly these are closely related species. *C. mitis* and *C. submitis* are distinguished from *C. sylvatica* primarily on the basis of chemical tests (11). Although subtle morphological differences may be correlated with the chemical differences, these are expressed largely as tendencies; and there seems to be little reason for maintaining *C. mitis* and *C. submitis* as distinct species.

Cladonia sylvatica f. *setigera* Oxner.

This form is distinguished from typical representatives of the species by the presence of minute, hair-like appendages at the tips of the branchlets and sometimes along the sides of the podetia.

3. CLADONIA MITIS Sandst.

A rare species found only on soil among boulders in the western mountainous region. (See *C. sylvatica*).

4. CLADONIA SUBMITIS Evans.

A rare species, found only on soil and rock fragments in shale barrens in the western mountainous region. (See *C. sylvatica*).

5. CLADONIA SUBTENUIS (des Abbayes) Evans. (FIG. 14, 15, 16, 17).

One of the commonest and most conspicuous of Virginia lichens, distributed throughout the state on soil and over mosses along roadside banks and in old fields and open woods, occasionly found on logs or old wood.

According to Evans (12), North American specimens which have been referred to *C. tenuis* (Floerke) Harm. differ morphologically from European specimens of this species in that they rarely form definite sympodia and the ultimate branchlets are either straight or curved in various directions, while the podetia of the latter exhibit a tendency to form distinct sympodia with the ultimate branchlets

FIG. 18–24.—Cladoniaceae of Virginia. FIG. 18. *Cladonia caroliniana* f. *dilatata* No. 4819. FIG. 19. *Cladonia caroliniana* f. *dilatata* No. 2230. FIG. 20. *Cladonia caroliniana* f. *tenuiramea* No. 2685. FIG. 21. *Cladonia uncialis* f. *soraligera* No. 2465. FIG. 22. *Cladonia uncialis* No. 2464. FIG. 23. *Cladonia uncialis* f. *polycrea* No. 2182. FIG 24 *Cladonia leporina* No. 1904.

distinctly curved, the curvature tending to be in one direction. He, therefore, referred all North American specimens to *C. subtenuis*. These slight differences seem hardly sufficient to necessitate the segregation of *C. subtenuis* from *C. tenuis*, if, indeed, *C. tenuis* should be separated from *C. sylvatica*.

Cladonia subtenuis f. setigera (des Abbayes) Evans.

This form is distinguished from typical representatives of *C. tenuis* by the presence of hair-like appendages on the podetia.

Subgenus 2. PYCNOTHELIA Ach.

6. CLADONIA PAPILLARIA (Ehrh.) Hoffm. (FIG. 3, 4, 5, 6, 7, 8).

A common and distinctive species since it is the only one with a persistent crustose primary thallus, distributed throughout the state on bare soil along roadside banks and in open woods and old fields. The forms of this species may be distinguished as follows:

1. Podetia rudimentary, small, globular, brown-tipped outgrowths (apparently a juvenile growth form) ..... *f. papillosa*
1. Podetia well developed 2
2. Apothecia sessile along the sides of the podetia ..... *f. epistelis*
2. Apothecia clustered on short terminal branches of the podetia or lacking ... 3
3. Podetia simple or sparingly and irregularly branched, often inflated and irregular in shape ..... *f. molariformis*
3. Podetia profusely branched toward the apex, the small cylindrical branches forming dense fastigiate clusters ..... *f. stipata*

Cladonia papillaria f. *molariformis* (Hoffm.) Schaer. (FIG. 4, 6, 7, 8).

Cladonia papillaria f. *papillosa* Fr. (FIG. 3).

Cladonia papillaria f. *stipata* Floerke. (FIG. 5)

Cladonia papillaria f. *epistelis* Sandst.

Subgenus 3. CENOMYCE (Ach.) Th. Fr.

Section 1. COCCIFERAE Del.

Subsection 1. SUBGLAUSCENTES Vainio

5. CLADONIA MACILENTA Hoffm. (FIG. 68, 69).

A fairly common species occurring throughout the state on soil, especially soil containing fragments of rotted wood, bark, and other plant debris, along roadside banks and in open woods, rarely on the base of pine trunks.

C. macilenta, *C. bacillaris*, and *C. floerkeana* are closely related species, and all specimens with short, cylindrical, simple or sparingly branched, grayish-green to whitish podetia which are corticate or ecorticate and farinose to granular sorediate and with red apothecia might well be placed in a single species. The K −, P − specimens of this type are divided between two species, *C. bacillaris* and *C. floerkeana* on the basis of extent of the corticate areas on the podetia. In the Virginia specimens that are referred to *C. floerkeana* the corticate areas in the upper parts of the podetia are limited to rings below the

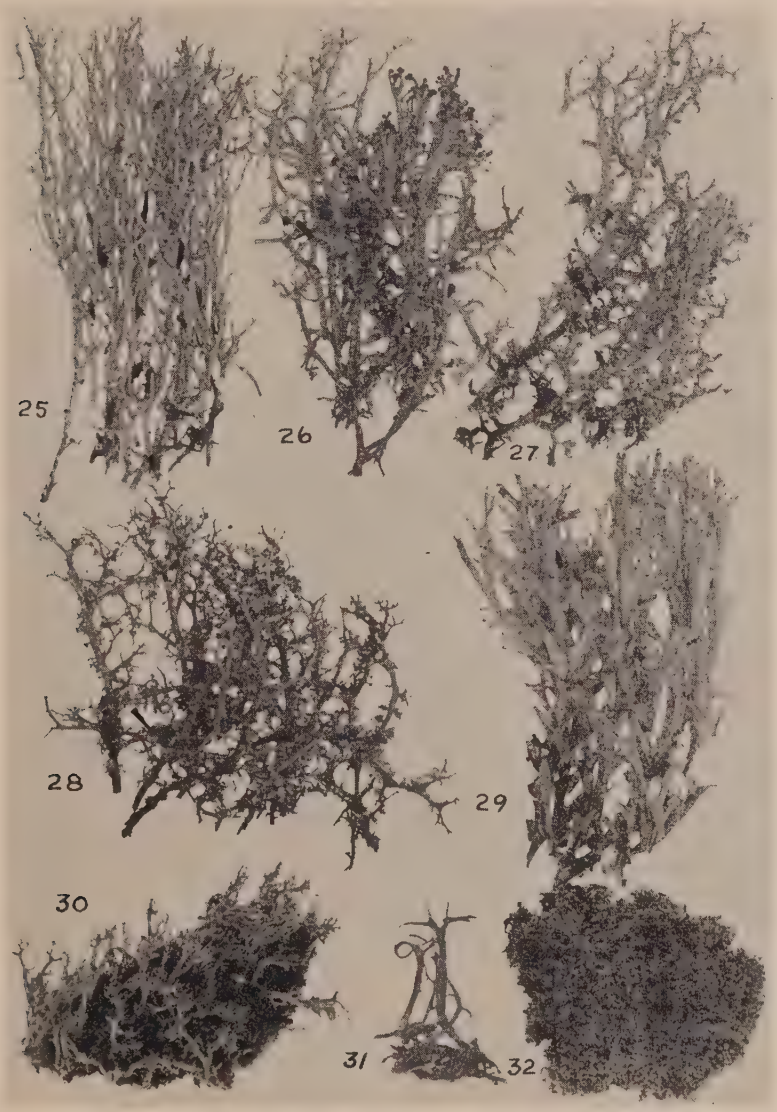

FIG. 25–32.—Cladoniaceae of Virginia. FIG. 25. *Cladonia furcata* var. *racemosa* f. *furcatosubulata* No. 2192. FIG. 26. *Cladonia furcata* var. *pinnata* f. *truncata* No. 524. FIG. 27. *Cladonia furcata* var. *pinnata* f. *foliolosa* No. 2360. FIG. 28. *Cladonia furcata* var. *racemosa* f. *squamulifera* No. 3882. FIG. 29. *Cladonia furcata* var. *racemosa* f. *fissa* No. 2191. FIG 30 *Cladonia floridana* f. *brachiata* No. 2054. FIG 31. *Cladonia farinacea* No. 3585. FIG. 32. *Cladonia caespiticia* No. 1541.

terminal apothecia. In sterile podetia in the same colony even these patches of cortex are lacking, and such podetia could not be distinguished from those of *C. bacillaris*. On the other hand, all K +, P + specimens, although they exhibit a greater range of variation from entirely corticate to ecorticate and farinose to granular sorediate podetia, are referred to the single species *C. macilenta*. Specimens placed under *C. ravenelii* lack the podetial cups produced by typical forms of this species; and while they may usually be distinguished from those in the preceding three species by their warty primary squamules and thick, warty podetial cortex, they intergrade to some extent with corticate forms of *C. macilenta*.

The collections have been distributed among four forms of *C. macilenta* which may be distinguished as follows:

1. Podetia more or less corticate throughout their entire length....*f. corticata*
1. Podetia ecorticate and farinose sorediate..... 2
2. Podetia squamulose throughout their entire length.....*f. squamigera*
2. Podetia esquamulose..... 3
3. Podetia slender.....*f. styracella*
3. Podetia stouter, larger, more densely sorediate.....*f. tomentosula*

Cladonia macilenta f. *styracella* (Ach.) Vainio.

Cladonia macilenta f. *corticata* Vainio. (FIG. 69).

Cladonia macilenta f. *squamigera* Vainio.

Cladonia macilenta f. *tomentosula* (Floerke) Aigret. (FIG. 68).

6. CLADONIA BACILLARIS (Ach.) Nyl. (FIG. 66, 67).

A common species throughout the state, on soil, fragments of rotted wood and bark, stumps and tree trunks (chiefly pines), and old logs along roadside banks and in fields and open woods. (See *C. macilenta*).

Cladonia bacillaris f. *clavata* (Ach.) Vainio.

This form includes specimens with simple podetia which are blunt at the tips and sterile or with terminal apothecia only. Specimens referred merely to the species are more variable, and the podetia may be branched toward the tips.

7. CLADONIA FLOERKEANA (Fr.) Floerke.

An uncommon species, found occasionally in various parts of the state on soil containing fragments of rotted wood and other plant debris along roadside banks and in open woods. (See *C. macilenta*).

The variety *intermedia* includes specimens with red apothecia and esquamulose podetia. In the variety *xanthocarpa* the apothecia are pale orange to yellowish.

Cladonia floerkeana var. *intermedia* Hepp.

Cladonia floerkeana var. *xanthocarpa* Nyl.

8. CLADONIA RAVENELII Tuck. (FIG. 64, 65).

A fairly common species in the Coastal Plain and Piedmont, on the

FIG. 33–44. Cladoniaceae of Virginia. FIG. 33. *Cladonia squamosa* No. 3815. FIG. 34. *Cladonia squamosa* No. 2633. FIG. 35. *Cladonia squamosa* f. *phyllocoma* No. 526. FIG. 36. *Cladonia conista* f. *simplex* No. 2331. FIG. 37. *Cladonia pyxidata* var. *neglecta* f. *simplex* No. 3272. FIG. 38. *Cladonia grayii* f. *prolifera* No. 3351. FIG. 39. *Cladonia grayii* f. *peritheta* No. 1653. FIG. 40. *Cladonia grayii* f. *carpophora* No. 1524. FIG. 41. *Cladonia grayii* f. *squamulosa* No. 1820. FIG. 42. *Cladonia incrassata* No. 3032. FIG. 43. *Cladonia incrassata* f. *squamulosa* No. 3125. FIG. 44. *Cladonia delicata* f. *quercina* No. 1822.

base of pines and pine stumps and on fragments of pine bark on the soil. (see *C. macilenta*).

9. CLADONIA DIDYMA (Fée) Vainio. (FIG. 63).

A fairly common species throughout the state, almost always on rotted wood and logs in open woods and along wooded roadsides, rarely on soil.

C. didyma and the following two species, *C. vulcanica* and *C. digitata*, differ from other species of the Subglaucentes in that the squamules and podetia are yellowish-green rather than grayish-green or whitish. Consequently, they might better be placed in the subsection Stramineo-flavidae.

Two forms of *C. didyma* occur in Virginia. In f. *subulata* the ecorticate podetia are pointed at the tips and usually sterile and are esquamulose. In f. *squamulosa* the podetia are larger and squamulose and are usually fertile.

Cladonia didyma f. *subulata* Sandst.

Cladonia didyma f. *squamulosa* Robbins. (FIG. 63).

10. CLADONIA VULCANICA Zolling. (FIG. 62)

A rare species found on logs and rotted wood in the Coastal Plain.

Specimens referred to *C. vulcanica* differ from those referred to *C. didyma* only in their reaction to K and P. Since no morphological differences are correlated with these chemical differences, *C. vulcanica* probably should be considered a synonym of *C. didyma*. The two collections of this species have been referred to the following form:

Cladonia vulcanica f. *minor* Robbins.

11. CLADONIA DIGITATA (L.) Hoffm. (FIG. 54).

A rare species found only in the western mountainous region of Virginia, on soil and rotted wood along roadside banks and on cliff ledges.

Subsection 2. STRAMINEO-FLAVIDAE

12. CLADONIA PLEUROTA (L.) Willd. (FIG. 56, 57).

A fairly common species distributed throughout the state on soil and plant litter in open woods and along roadside banks.

Specimens of the type placed here under *C. pleurota* have generally been divided between two species, *C. coccifera* (L.) Willd. for forms with corticate podetia and *C. pleurota* for forms with ecorticate and farinose to granular sorediate podetia. The podetia in one of the Virginia collections (No. 3423, Elliott's Knob, Agusta Co., Luttrell, 10 May, 1942) are corticate, and this collection might be referred to *C. coccifera*. However, Evans (12) has suggested that these two species be separated on the basis of lichen acid content, specimens containing usnic and barbatic acids but no zeorine being referred to *C. coccifera*, those containing usnic acid and zeorine but no barbatic acid to *C. pleurota*. As thus defined *C. pleurota* includes both corticate and ecorticate forms,

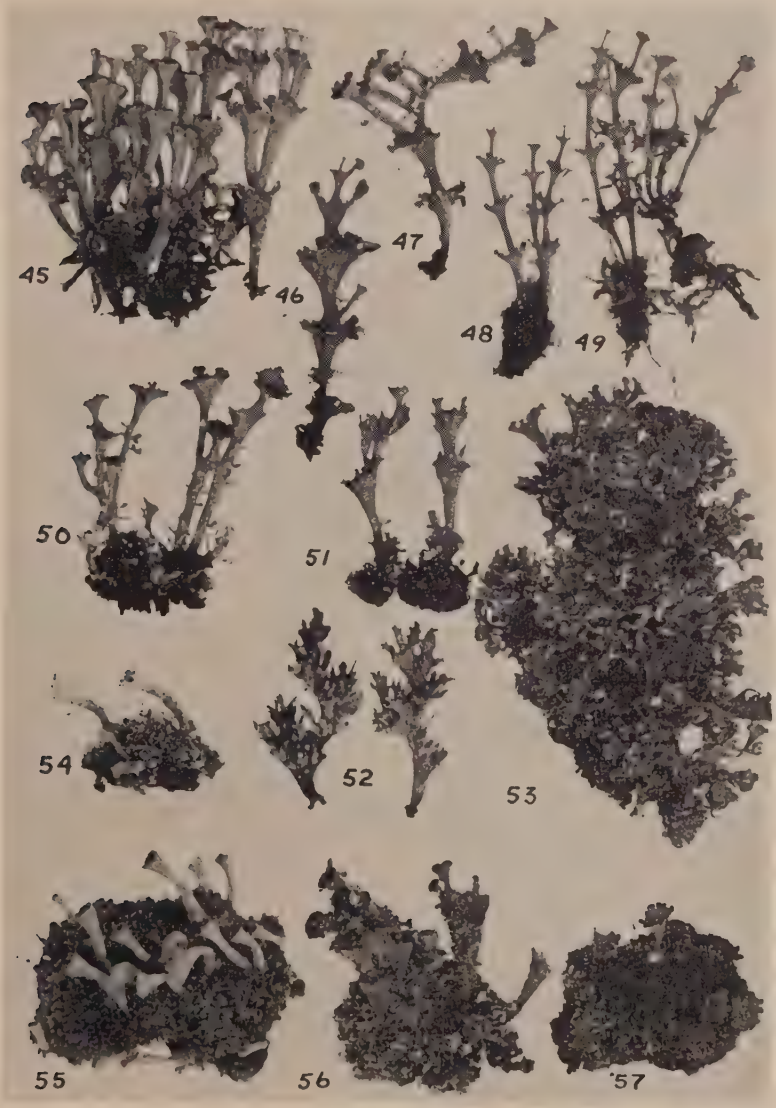

FIG. 45–57. Cladoniaceae of Virginia. FIG. 45. *Cladonia verticillata* f. *evoluta* No. 1503. FIG. 46. *Cladonia varticillata* f. *phyllocephala* No. 4842. FIG. 47. *Cladonia verticillata* f. *apoticta* No. 532. FIG. 48. *Cladonia calycantha* No. 2055. FIG. 49. *Cladonia calycantha* No. 1851. FIG. 50. *Cladonia gracilis* var. *dilatata* No. 3422. FIG. 51. *Cladonia mateocyatha* f. *squamulata* No. 3067. FIG. 52. *Cladonia mateocyatha* f. *squamulata* No. 3931. FIG. 53. *Cladonia mateocyatha* No. 1819. FIG. 54. *Cladonia digitata* No. 2211. FIG. 55. *Cladonia fimbriata* No. 3773. FIG. 56. *Cladonia pleurota* No. 3423. FIG. 57. *Cladonia pleurota* f. *decorata* No. 3111.

and only *C. pleurota* occurs in Virginia. Since these chemical differences are not correlated with morphological differences it would seem desirable to reduce *C. pleurota* to synonomy and to recognize only the single species *C. coccifera* for the entire group.

Sterile specimens of *C. pleurota* lacking the characteristic red apothecia may be confused with sterile specimens of *C. pyxidata*, *C. chlorophaea*, *C. grayii*, *C. cryptochlorophaea*, and *C. conista* which when fruiting produce brown apothecia. The K −, P − reactions of *C. pleurota* will distinguish it from all of these brown-fruited forms except K −, P − specimens of *C. grayii* as may be seen from the following list of species and their reactions: *C. pleurota* K −, P −; *C. grayii* K −, P− or P + red; *C. pyxidata* K −, P + red; *C. chlorophaea* K −, P + red; *C. cryptochlorophaea* K + red, P − or P + red, *C. conista* K + brown, P + red. The identity of K −, P − sterile specimens can be determined only by a test for the presence or absence of zeorine (10).

Cladonia pleurota f. *decorata* Vainio. (FIG. 57).

A form with broad, flaring cups and conspicuous red apothecia.

Cladonia pleurota var. *frondescens* (Nyl.) Oliv.

This variety includes specimens with squamulose podetia.

13. CLADONIA CRISTATELLA Tuck. (FIG. 58, 59, 60, 61).

One of the most common species throughout the state, on soil, rotted wood, and litter in open woods and old fields and along roadside banks, occasionally on pine logs and trunks of trees and on shingle roofs of sheds.

The specimens are referred to several forms which may be distinguished by the following key;

1. Podetia terminated by shallow cup-like expansions formed by whorls of partially fused branches at the apex ..... *f. scyphulifera*
1. Podetia simple or sparingly branched toward the apex 2
2. Apothecia yellow to flesh colored ..... *f. ochrocarpia*
2. Apothecia red 3
3. Apothecia sessile or short-pedicillate from the sides of the podetia *f. pleurocarpa*
3. Apothecia terminal 4
4. Podetia squamulose ..... *f. vestita*
4. Podetia lacking squamules ..... *f. beauvoisii*

Cladonia cristatella f. *beauvoisii* (Del. Vainio. (FIG. 58, 60, 61).

Cladonia cristatella f. *vestita* Tuck (FIG. 59)

Cladonia cristatella f. *scyhulifera* Sandst.

Cladonia cristatella f. *pleurocarpa* Robbins.

Cladonia cristatella f. *ochrocarpia* Tuck.

14. CLADONIA INCRASSATA Floerke. (FIG. 42, 43).

This species is fairly common in certain localities throughout the state. It occurs usually on rotted decorticated pine stumps and less frequently on hardwood stumps in open woods. It was found once on a log and once on soil at the base of an oak.

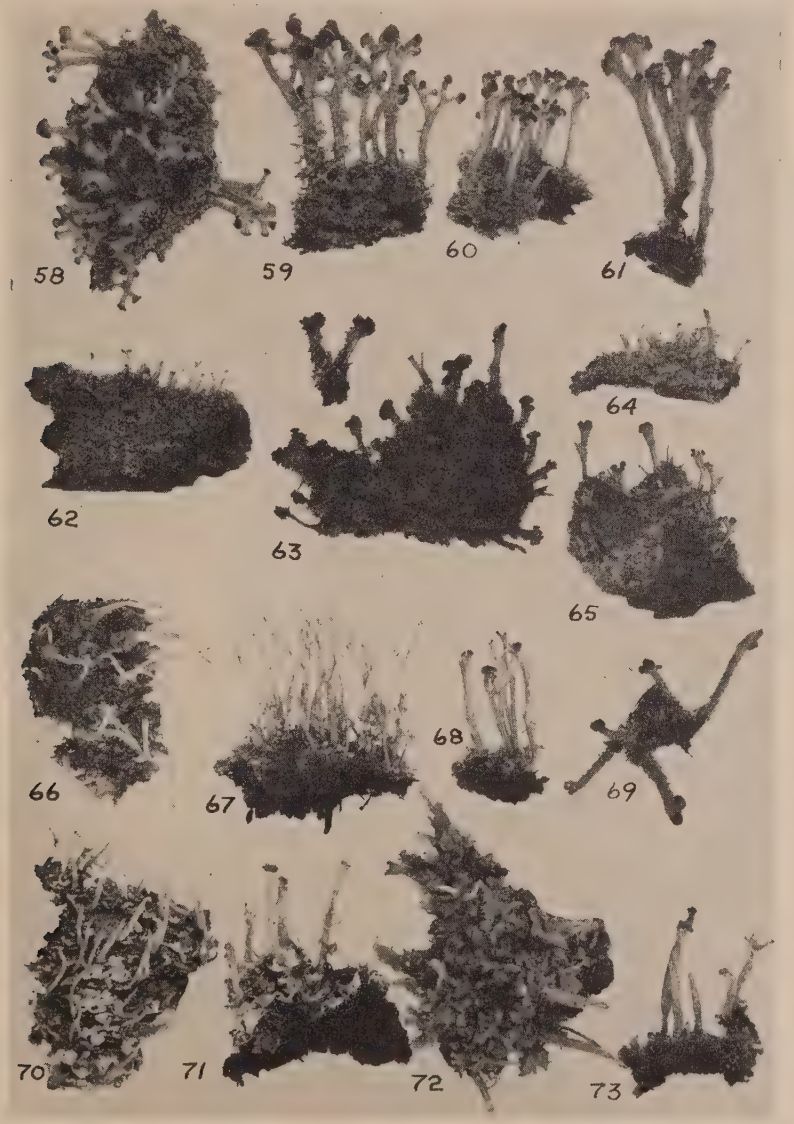

FIG. 58–73.—Cladoniaceae of Virginia. FIG. 58. *Cladonia cristatella* f. *beauvoissi* No. 1897. FIG. 59. *Cladonia cristatella* f. *vestita* No. 3518. FIG. 60-61. *Cladonia cristatella* f. *beauvoisii* No. 4882. FIG. 62. *Cladonia vulcanica* f. *minor* No. 3695. FIG. 63. *Cladonia didyma* f. *squamulosa* No. 2079. FIG. 64. *Cladonia ravenelii* No. 1976. FIG. 65. *Cladonia ravenelii* No. 1539. FIG. 66. *Cladonia bacillaris* No. 3771. FIG. 67. *Cladonia bacillaris* No. 4090. FIG. 68. *Cladonia macilenta* f. *tomentosula* No. 4091. FIG. 69. *Cladonia macilenta* f. *corticata* No. 2669. FIG. 70. *Cladonia coniocraea* f. *ceratodes* No. 2251. FIG. 71. *Cladonia coniocraea* f. *truncata* No. 1555. FIG. 72. *Cladonia coniocraea* f. *expansa* No. 1649. FIG. 73. *Cladonia ochrochlora* No. 2662.

Cladonia incrassata f. *squamulosa* (Robbins) Evans.

A form with squamulose podetia.

Subsection 3. LEPORINAE Evans

15. CLADONIA LEPORINA Fr.. (FIG. 24).

This species has been collected only twice in the extreme southeastern part of the state, once on sand under pines at the base of a sand dune and once on sandy soil in a pine barren. Both specimens were poorly developed. Since *C. leporina* is characteristically a species of the southern Coastal Plain, occurring commonly in the sand hills of North Carolina, its rarity in Virginia is surprising in view of the fact that it has been reported in New Jersey (8).

Section 2. OCHROPHAEAE Vainio

Subsection 1. UNCIALES (Del.) Vainio

16. CLADONIA UNCIALIS (L.) Web. (FIG. 21, 22, 23).

Characteristically a species of the western mountainous region of Virginia where it usually occurs on cliff ledges and in shale barrens, also found on soil along roadside banks, found once on sandy soil in a pine barren in the Coastal Plain.

A few collections have been assigned to the following forms:

Cladonia uncialis f. *polycraea* (Floerke) Sandst. (FIG. 23).

A form in which the ultimate branchlets are arranged in whorls surrounding a perforation in the podetial wall.

Cladonia uncialis f. *soraligera* Robbins. (FIG. 21).

In this form large, irregular masses of soredia are produced on the surface of the podetia.

Cladonia uncialis f. *spinosa* Oliv.

A proliferous form with spinose outgrowths from the sides of the prostate podetia.

17. CLADONIA CAROLINIANA (Schwein.) Tuck. (FIG. 18, 19, 20).

A fairly common species in some localities throughout the state, occurring on soil in open woods, along roadside banks, and in pine barrens, heath balds, and shale barrens.

Cladonia caroliniana f. tenuiramea Evans. (FIG. 20).

Podetia slender (not more than 1 mm. in diameter), relatively uniform in diameter, regularly dichotomously or polytomously branched.

Cladonia caroliniana f. *dilatata* Evans. (FIG. 18, 19).

Podetia dilated or irregularly inflated, especially toward the apex, 1–2 mm. in diameter, irregularly branched.

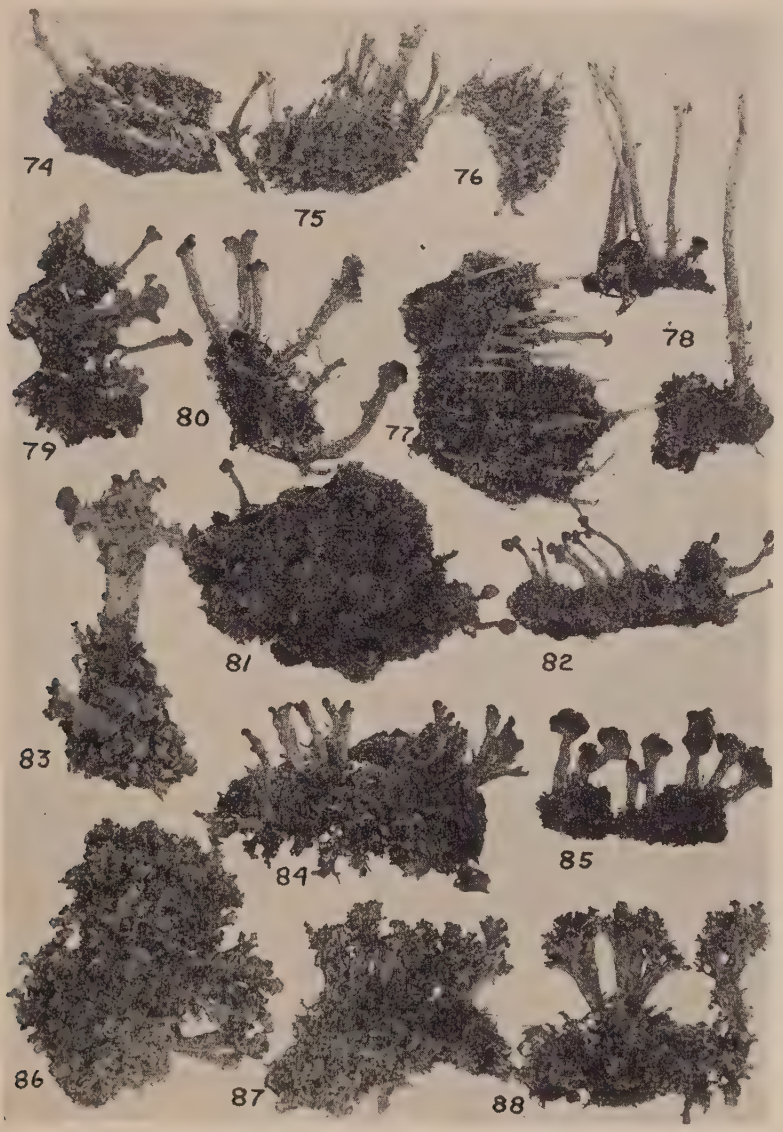

FIG. 74–88. Cladoniaceae of Virginia. FIG. 74. *Cladonia pityrea* var. *zwackhii* f. *cladomorpha* No. 1935. FIG. 75. *Cladonia cylindrica* f. *scyphifera* No. 1982. FIG. 76. *Cladonia cylindrica* No. 4092. FIG. 77. *Cladonia pityrea* var. *zwackhii* f. *cladomorpha* No. 1935. FIG. 78. *Cladonia nemoxyna* No. 2533. FIG. 79. *Cladonia piedmontensis* f. *obconica* No. 1896. FIG. 80 *Cladonia piedmontensis* f. *squamulosa* No. 1519. FIG. 81. *Cladonia capitata* f. *imbricatula* No. 1523. FIG. 82. *Cladonia capitata* f. *imbricatula* No. 1733. FIG. 83. *Cladonia subcariosa* f. *squamulosa* No. 4810. FIG. 84. *Cladonia subcariosa* f. *evoluta* No. 2198. FIG. 85. *Cladonia brevis* No. 1831. FIG. 86. *Cladonia strepsilis* f. *glabrata* No. 2017. FIG. 87. *Cladonia strepsilis* f. *coralloidea* No. 4841. FIG. 88. *Cladonia strepsilis* f. *coralloidea* No. 4876.

Subsection 2. CHASMARIAE (Ach.) Vainio

Group 1. MICROPHYLLAE Vainio

18. CLADONIA FURCATA (Huds.) Schrad. (FIG. 25, 26, 27, 28, 29).

A very common species in the western mountainous region of the state, extending into the Piedmont and found once in the Coastal Plain, on soil and over mosses in open woods and along wooded roadside banks.

The collections have been distributed among a number of varieties and forms which may be distinguished by the following key:

1. Podetia pale to dark greenish gray 2
1. Podetia brownish. . . Var. *palamaea* 8
2. Podetial cortex smooth, subcontinuous, usually lacking squamules . . . Var. *racemosa* 3
2. Podetial cortex thick, broken, often with transverse splits, typically squamulose. . . . Var. *pinnata* 7
3. Podetia squamulose ..... Var. *racemosa* f. *squamulifera*
3. Podetia lacking squamules 4
4. Podetia with numerous lengthwise splits through the podetial wall. ..... Var. *racemosa* f. *fissa*
4. Podetia not split or with few longitudinal splits 5
5. Podetia branching polytomously, especially in the upper parts. ..... Var. *racemosa* f. *subclausa*
5. Podetia dichotomously branched 6
6. Podestia sterile, with pointed tips ..... Var. *racemosa* f. *furcatosubulata*
6. Podetia fertile, with apothecia at tips ..... Var. *racemosa* f. *corymbosa*
7. Podetia sterile, with pointed tips ..... Var. *pinnata* f. *foliolosa*
7. Podetia fertile, with terminal apothecia ..... Var. *pinnata* f. *truncata*
8. Podetia squamulose ..... Var. *palamea* f. *rigidula*
8. Podetia lacking squamules ..... Var. *palamea* f. *subulata*

Cladonia furcata var. *racemosa* (Hoffm.) Floerke.

Cladonia furcata var. *racemosa* f. *furcatosubulata* (Hoffm.) Vainio. (Fig. 25).

Cladonia furcata var. *racemosa* f. *corymbosa* (Ach.) Vainio.

Cladonia furcata var. *racemosa* f. *subclausa* Sandst.

Cladonia furcata var. *racemosa* f. *fissa* (Floerke) Aigret. (FIG. 29).

Cladonia furcata var. *racemosa* f. *squamulifera* Sandst. (FIG. 28).

Cladonia furcata var. *pinnata* f. *truncata* (Floerke) Vainio. (FIG. 26).

Cladonia furcata var. *pinnata f. foliolosa* (Del.) Vainio. (FIG. 27).

Cladonia furcata var. *palamaea* (Ach.) Vainio.

Cladonia furcata var. *palamaea* f. *subulata* (Ach.) Vainio.

Cladonia furcata var. *palamaea* f. *rigidula* (Mass.) Oliv.

19. CLADONIA FARINACEA (Vainio) Evans. (FIG. 31).

A rarity in the Virginia flora, this species has been found only once in the Coastal Plain, on soil along a roadside bank in open woods.

20. CLADONIA SQUAMOSA (Scop.) Hoffm. (FIG. 33, 34, 35).

A common species, distributed throughout the state but occurring most abundantly in the western mountainous region, on soil, rotted wood, and logs in open woods and along roadside banks.

The collections have been distributed among a number of forms which may be distinguished by the following key:

1. Podetia forming distinct cups which open into the podetial cavity..... 2
1. Podetia not forming cups..... 6
2. Podetia ecorticate in the upper parts..... 3
2. Podetia corticate throughout..... 4
3. Podetia densely squamulose.....f. *squamosissima*
3. Podetia lacking squamules or sparingly squamulose.....f. *denticollis*
4. Podetia whitish or ashy, with large squamules.....f. *phyllocoma*
4. Podetia greenish gray or brownish, esquamulose or with medium-sized squamules . . . f. *levicorticata*..... 5
5. Apothecia numerous, podetia smooth or sparingly squamulose . . . .f. *levicorticata* m. *pityrea*
5. Apothecia usually present but not abundant, podetia often squamulose, podetial cups marginally proliferous, proliferations short, spreading, rigid. .....f. *levicorticata* m. *rigida*
6. Podetia well developed, corticate.....f. *mucronata*
6. Podetia short, abortive, primary squamules large, persistent.....f. *murina*

Cladonia squamosa f. *levicorticata* Sandst.

Cladonia squamosa f. *levicorticata* m. *rigida* (Del.) Evans.

Cladonia squamosa f. *levicorticata* m. *pityrea* (Arn.) Evans.

Cladonia squamosa f. *denticollis* (Hoffm.) Floerke.

Cladonia squamosa f. *squamosissima* Floerke.

Cladonia squamosa f. *phyllocoma* (Rabenh.) Vainio. (FIG. 35).

Cladonia squamosa f. *murina* Scriba.

21. CLADONIA ATLANTICA Evans.

A fairly common species, occurring throughout the state but more frequent in the Coastal Plain and eastern Piedmont, on soil and rotted wood in open woods.

Specimens which give a P + yellow reaction have been segregated from *C. squamosa* as *C. atlantica* by Evans (12). Since there are no morphological differences between P − and P + yellow specimens, *C. atlantica* probably should be considered a synonym of *C. squamosa*.

A few collections have been referred to distinct forms of the species. These forms may be separated by the following key:

1. Podetial cortex interrupted by ecorticate areas, podetia lacking cups or with indistinct cups, simple or sparingly branched, more or less squamulose. .....f. *microphylla*
1. Podetial cortex continuous or nearly so..... 2
2. Podetia with distinct cups, repeatedly branched, more or less squamulose. .....f. *ramosa*
2. Podetia lacking distinct cups, repeatedly and intricately branched, more or less squamulose.....f. *ramosissima*

Cladonia atlantica f. *ramosa* Evans.

Cladonia atlantica f. *ramosissima* Evans.

Cladonia atlantica f. *microphylla* Evans.

22. CLADONIA FLORIDANA Vainio. (FIG. 30).

This species has been collected only once in the southeastern Coastal Plain of Virginia where it occurred on sandy soil in a pine barren. Its rarity is surprising since it occurs in the North Carolina Coastal Plain and has been reported in Maryland (19), New Jersey (6), and Pennsylvania (2). This single collection has been referred to the following form.

Cladonia floridana f. *brachiata* Robbins.

23. CLADONIA DELICATA (Ehrh.) Floerke. (FIG. 44).

A fairly common species distributed throughout the state; found only on decorticated hardwood stumps and logs in open woods. All collections have been referred to the following form.
Cladonia delicata f. *quercina* (Pers.) Vainio.

24. CLADONIA CAESPITICIA (Pers.) Floerke. (FIG. 32).

A fairly common species throughout Virginia on soil along roadside banks and in open woods and on tree trunks. The form *corticata*, including specimens with better developed, corticate podetia about three mm. long, has been found only on tree trunks.

Cladonia caespiticia f. *corticata* Sandst.

Group 2. MEGAPHYLLAE Vainio

25. CLADONIA APODOCARPA Robbins. (FIG. 9).

A common species throughout the state on soil along roadside banks and in open woods. Usually sterile; only two fruiting specimens have been collected.

Subsection 3. CLAUSAE Vainio

Group 1. PODESTELIDES (wallr.) Vainio

Subgroup 1. HELOPODIUM (Ach.) Vainio

26. CLADONIA CAPITATA (Michx.) Spreng. (FIG. 81, 82).

A common species throughout the state, on soil along roadside banks and in old fields and open woods.

The forms of this species may be distinguished as follows:

1. Podetia more or less squamulose ..... f. *squamulosa*
1. Podetia lacking squamules 2
2. Apothecia small, numerous in compact clusters ..... f. *microcarpa*
2. Apothecia large, not in clusters 3
3. Apothecia pale to dark brown ..... f. *imbricatula*
3. Apothecia flesh-colored ..... f. *pallida*

Cladonia capitata f. *imbricatula* (Nyl.) Evans. (Fig. 81, 82).

Cladonia capitata f. *microcarpa* (Evans) Evans.

Cladonia capitata f. *pallida* (Robbins) Evans.

Cladonia capitata f. *squamulosa* (Merrill) Evans.

27. Cladonia subcariosa Nyl. (Fig. 83, 84).

A very common species throughout the state, on soil along roadside banks and in old fields and open woods.

C. subcariosa, *C. clavulifera*, *C. polycarpia*, and *C. brevis* form a group of closely related species. These four species are separated primarily on the basis of chemical differences which are indicated by their reactions with K and P. Although they are variable in morphology, the morphological variations are not correlated with the chemical differences. Consequently, the entire group might well be referred to a single species under the name *C. subcariosa*.

Cladonia subcariosa f. *evoluta* Vainio. (Fig. 84).

Podetia simple or sparingly branched, terminated by one or a few large apothecia, lacking squamules.

Cladonia subcariosa f. *squamulosa* Robbins. (Fig. 83).

Podetia similar to those of the form *evoluta* but squamulose.

28. Cladonia clavulifera Vainio.

A common species throughout the state, occurring in the same habitats as *C. subcariosa* which it strongly resembles. (See *C. subcariosa*).

Cladonia clavulifera f. *nudicaulis* Evans.

Podetia simple or sparingly branched, terminated by one or a few large apothecia, lacking squamules except at the base.

Cladonia clavulifera f. *subvestita* Robbins.

Resembling the form *nudicaulis* but with the podetia more or less squamulose throughout.

29. Cladonia polycarpia Merrill.

A rare species, found only in the southeastern Coastal Plain on soil in a pine barren and along a roadside bank. (See *C. subcariosa*).

30. Cladonia brevis Sandst. (Fig. 85).

An uncommon species but distributed throughout the state, on soil in open woods and along roadside banks. (See *C. subcariosa*).

Group 2. thallostelides Vainio

31. Cladonia gracilis (L.) Willd. (Fig. 50).

A rarity in Virginia, this species has been collected only twice in the western mountainous region of the state, once on a rotted stump

and once over mosses and plant litter on sandstone boulders in open woods. Both collections may be referred to the following variety.

Cladonia gracilis var. *dilatata* (Hoffm.) Vainio.

32. CLADONIA VERTICILLATA (Hoffm.) Schaer. (FIG. 45, 46, 47).

A very common species, occurring throughout the state on soil in old fields and open woods and along roadside banks.

The majority of the collections may be divided among three forms of the species. These forms may be distinguished as follows:

1. Podetia more or less squamulose.....f. *phyllocephala*
1. Podetia lacking squamules..... 2
2. Podetia proliferating only from the centers of the cups.....f. *evoluta*
2. Podetia with proliferations along the sides of the podetia as well as from the centers of the cups.....f. *apoticta*

Cladonia verticillata f. *evoluta* (Th. Fr.) Stein. (FIG. 45).

Cladonia verticillata f. *apoticta* (Ach.) Vainio. (FIG. 47).

Cladonia verticillata f. *phyllocephala* (Flot.) Oliv. (FIG. 46).

33. CLADONIA CALYCANTHA Del. (FIG. 48, 49).

A rather uncommon species, found only in the Coastal Plain and eastern Piedmont, on soil in old fields and along roadside banks.

C. calycantha appears to be only a more delicate growth form of *C. verticillata* and probably should be reduced to synonomy with this species. The podetia are more or less squamulose in the form *foliolosa*.

Cladonia calycantha f. *foliolosa* Vainio.

34. CLADONIA MATEOCYATHA Robbins. (FIG. 51, 52, 53).

A common species throughout the state, on soil in old fields and open woods and along roadside banks.

Cladonia mateocyatha f. *leioscypha* Evans.

Podetia lacking squamules.

Cladonia mateocyatha f. *squamulata* Robbins. (FIG. 51, 52).

Podetia more or less squamulose.

35. CLADONIA PYXIDATA (L.) Hoffm. (FIG. 37).

An uncommon species, found only in the western mountainous region of the state, on soil in open woods and along roadside banks.

C. pyxidata, *C. chlorophaea*, *C. grayii*, *C. cryptochlorophaea*, and *C. conista* form a group of closely related species. *C. chlorophaea* and *C. conista* are separated from *C. pyxidata*, in which the podetia are corticate, by their ecorticate, sorediose podetia, the soredia being granular in *C. chlorophaea* and farinose in *C. conista*. Granular sorediose forms containing grayanic acid are segregated from *C. chlorophaea* as *C. grayii* and those containing cryptochlorophaeic acid as *C. cryptochlorophaea*. The separation of *C. pyxidata* and *C. chlorophaea* on the basis

of presence or absence of soredia is hardly justified because of intergradations between the two conditions. Furthermore, there are variations in size of soredia in both *C. chlorophaea* and *C. conista*, and the distinction between these two species is not always clear. The separation of *C. grayii* and *C. cryptochlorophaea* is based solely on differences in lichen acid content that are unaccompanied by any morphological differences. Consequently, it might be desirable to reduce *C. chlorophea*, *C. grayii*, *C. cryptochlorophaea*, and *C. conista* to synonomy with *C. pyxidata*.

All Virginia specimens with corticate podetia have been referred to the variety *neglecta* form *simplex* of *C. pyxidata* in which the podetia are esquamulose, non-proliferous, and sterile or with apothecia sessile on the margins of the cups. However, in most of the collections there are admixtures of two additional forms of the variety *neglecta:* f. *lophyra* (Ach.) Koreb., in which the podetia are squamulose, and f. *peritheta* (Wallr.) Robbins, in which cup-forming proliferations are produced from the outer surface of the primary podetial cups.

Cladonia pyxidata var. *neglecta* f. *simplex* (Ach.) Harm. (Fig. 37).

36. Cladonia chlorophaea (Floerke) Spreng.

An uncommon species, distributed throughout the state, on soil in open woods and along roadside banks. (See *C. pyxidata*).

Cladonia chlorophaea f. *simplex* (Hoffm.) Arn.

Podetial cups non-proliferous, lacking apothecia.

Cladonia chlorophaea f. *carpophora* (Floerke) Anders.

Podetia fertile, with sessile or short-stipitate apothecia on the margins of the cups.

37. Cladonia grayii Merrill (Fig. 38, 39, 40, 41).

A very common species, occurring throughout the state on soil in open woods and along roadside banks. (See *C. pyxidata*).

Many of the collections have been referred to definite forms of the species. These forms may be distinguished as follows:

1. Podetial cups producing cup-forming proliferations 2
1. Podetial cups not producing cup-forming proliferations 3
2. Proliferations from the margins of the primary cups ..... f. *prolifera*
2. Proliferations from the outer surface of the primary cups ..... f. *peritheta*
3. Podetia squamulose ..... f. *squamulosa*
3. Podetia lacking squamules 4
4. Podetia usually sterile, short, forming broad, shallow cups ..... f. *cyathiformis*
4. Podetia fertile, with numerous sessile or short- to long-stipitate apothecia on the margins of the cups ..... f. *carpophora*

Cladonia grayii f. *cyathiformis* Sandst.

Cladonia grayii f. *carpophora* Evans. (Fig. 40).

Cladonia grayii f. *peritheta* Evans. (Fig. 39).

Cladonia grayii f. *prolifera* Sandst. (Fig. 38).

Cladonia grayii f. *squamulosa* Sandst. (Fig. 41).

38. CLADONIA CRYPTOCHLOROPHAEA Asahina.

A rather uncommon species, occurring throughout the state, on soil in open woods and along roadside banks. (See *C. pyxidata*).

39. CLADONIA CONISTA (Ach.) Robbins. (FIG. 36).

An uncommon species, distributed throughout the state, on soil in open woods and along roadside banks. (See *C. pyxidata*).

All collections have been referred to the following form in which the podetial cups are non-proliferous and usually sterile.

Cladonia conista f. *simplex* Robbins.

40. CLADONIA FIMBRIATA (L.) Fr. (FIG. 55).

A fairly common species in the western mountainous region of the state and extending into the Piedmont, on soil and plant litter in open woods and along roadside banks.

41. CLADONIA CONIOCRAEA (Floerke) Spreng. (FIG. 70, 71, 72).

A very common species throughout the state, on tree trunks, logs, and, rarely, soil in open woods.

Specimens in which a larger proportion of the basal area of the podetia and the inner surface of the cups, when present, are corticate have been segregated as *C. ochrochlora*. However, these slight quantitative differences do not seem sufficient to necessitate the recognition of two distinct species.

The majority of the collections have been referred to definite forms of the species. These forms may be distinguished as follows:

1. Podetia squamulose.....f. *phyllostrota*
1. Podetia lacking squamules..... 2
2. Podetia blunt at tips, with a pronounced depression in the blunted tip, or forming narrow cups, often fertile.....f. *truncata*
2. Podetia tapering to pointed tips, sterile..... 3
3. Primary squamules very large, ascending.....f. *expansa*
3. Primary squamules medium-sized..... 4
4. Podetia medium-sized.....f. *ceratodes*
4. Podetia large, up to 2.5 mm. in diameter.....f. *robustior*

Cladonia coniocraea f. *ceratodes* (Floerke) Dalla Torre & Sarnth. (FIG. 70).

Cladonia coniocraea f. *expansa* (Floerke) Sandst. (FIG. 72).

Cladonia coniocraea f. *phyllostrota* (Floerke) Vainio.

Cladonia coniocraea f. *robustior* (Harm.) Sandst.

Cladonia coniocraea f. *truncata* (Floerke) Dalla Torre & Sarnth. (FIG. 71).

42. CLADONIA OCHROCHLORA Floerke. (FIG. 73).

An uncommon species, found only in the western mountainous region of the state, in the same habitats as *C. coniocraea* with which it is probably synonymous. (See *C. coniocraea*).

43. CLADONIA NEMOXYNA (Ach.) Nyl. (FIG. 78).

A rarity in the Virginia flora, this species has been collected only twice, once on sandy soil in a meadow in the western mountains and once on soil in an old field in the Piedmont.

44. CLADONIA CYLINDRICA Evans. (FIG. 75, 76).

A fairly common species, occurring throughout the state on tree trunks, logs, and soil in open woods.

Cladonia cylindrica f. *squamulosa* (Robbins) Evans.

A form with squamulose podetia.

Cladonia cylindrica f. *scyphifera* Evans. (FIG. 75).

Podeta forming distinct cups at the tips.

45. CLADONIA PITYREA (Floerke) Fr. (FIG. 74, 77).

A rather uncommon species, found throughout the state, on tree trunks, logs, and soil in open woods.

Two forms of this species are represented in the Virginia collections.

Cladonia pityrea var. *zwackhii* f. *subacuta* Vainio.

Podetia lacking cups, simple or sparingly branched, sterile or occasionally fertile, granular sorediose.

Cladonia pityrea var. *zwackhii* f. *cladomorpha* (Floerke) Vainio. (FIG. 74, 77).

Podetia with distinct cups at the tips, cups irregular, often with apothecia on short marginal stipes, granular sorediose.

46. CLADONIA ROBBINSII Evans. (FIG. 10).

A rare species, found only in the western mountainous region of the state, on soil in shale barrens and heath balds.

C. robbinsii was segregated from *C. foliacea* (Huds.) Willd. by Evans (12). It differs from *C. foliacea* in the presence of barbatic acid and absence of fumarprotocetraric acid. *C. robbinsii* is P −, *C. foliacea* P + red. *C. robbinsii* also lacks the marginal rhizinae which are present on the primary squamules of most forms of *C. foliacea*. It seems doubtful that this is sufficient basis for the recognition of a distinct species.

47. CLADONIA STREPSILIS (Ach.) Vainio. (FIG. 86, 87, 88).

A fairly common species throughout the state, on soil in open woods and old fields and along roadside banks.

Cladonia strepsilis f. *glabrata* Vainio. (FIG. 86).

A form with well-developed podetia lacking squamules.

Cladonia strepsilis f. *coralloidea* (Ach.) Vainio. (FIG. 87, 88).

Podetia well developed, squamulose.

Cladonia strepsilis f. *subsessilis* Vainio.

Podetia short, abortive or poorly developed.

Group 4. OCHROLEUCAE Fr.

48. CLADONIA PIEDMONTENSIS Merrill. (FIG. 79, 80).

A fairly common species in the Coastal Plain and Piedmont, on soil in old fields and open woods and along roadside banks.

Cladonia piedmontensis f. *obconica* Robbins. (FIG. 79).

Podetia simple or nearly so, expanding toward the apex, lacking squamules except at the base, apothecia large.

Cladonia piedmontensis f. *squamulosa* Robbins. (FIG. 80).

Podetia as in f. *obconica* but squamulose.

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A Revision of the Michigan Species of Lepiota

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The only published account of the genus Lepiota in Michigan is that of Kauffman (1918). Since that time many changes in the classification of the genus have been proposed, and many additional collections have been made in the state. Kauffman recorded 26 species for Michigan. Only 18 of these would now be recognized as belonging in Lepiota. The others have been transferred to Limacella (H. V. Smith, 1941), and Cystoderma (A. H. Smith and Singer, 1944). A. H. Smith (1941) described two additional species and reported on some more. In this report 32 species are recorded for the state.

Modern classifications of this diversified genus give great importance to the structure of the cuticle of the pileus and the characters of the spores. Locquin (1945), Kuhner (1936) and Kuhner and Romagnesi (1953) have made important contributions to the taxonomy of the genus, and the classification presented here is theirs with some modifications.

In many respects this genus is a very unsatisfactory one to study. The species do not fruit with any regularity, in fact, since I took an interest in the genus more than ten years ago we have not had a really good season for them. It seems likely that if a good season should be encountered, particularly in the southern part of the state, a number of additions to our flora would be expected. In spite of the fact that they are sporadic in their fruiting habits, Lepiotas are an important part of the state's agaric flora since the subgenus Leucocoprinus contains important edible species as well as an important poisonous one.

I wish to thank my husband, Alexander H. Smith of the University of Michigan Herbarium, for turning over his collections and notes to me and for assistance and suggestions throughout the course of the work. Through the courtesy of Dr. E. B. Mains, Director, the material deposited in the University Herbarium was made accessible for this study. I also wish to acknowledge the collections made by Mr. Victor Potter of Ithaca, Mich. All of this material in addition to my own collections, forms the basis for the present revision. All of these collections have been deposited in the University of Michigan Herbarium.

The color names in quotation marks are taken from R. Ridgeway, Color Standards and Color Nomenclature, Washington, D. C., 1912.

KEY TO GROUPS OF MICHIGAN LEPIOTAS

A. Spores with a thick wall and apical germ pore...*Subgenus Leucocoprinus, p.* 308
A. Spores without a germ pore.....*Subgenus Eu-lepiota*
1. Pileus smooth, cuticle unruptured, hymeniform.....*Integrellae, p.* 313
1. Cuticle not a continuous hymeniform layer..... 2
2. Spores fusiform.....*Clypeolariae, p.* 314
2. Spores not fusiform..... 3
3. Spores truncate at apiculate end.....*Stenosporae, p.* 315
3. Spores not truncate at apiculate end..... 4
4. Pileus surface and stipe at first covered by sphaerocysta, these often persisting and the surface powdery.....*Micaceae, p.* 317
4. Pileus surface not covered with sphaerocysts..... 5
5. Pileus and often the stipe covered at least at first by pyramidal warts, these composed of short-cylindric and subglobose cells usually with intermixed long hyphae.*Echinatae, p.* 320
5. Covering of pileus not as above, fibrillose, floccose-fibrillose or innately fibrillose.....*Ovisporae, p.* 322

SUBGENUS LEUCOCOPRINUS

KEY TO SPECIES

1. Flesh thin, margin of pileus typically becoming striate or radiately innately silky..... 2
2. Greenhouse species (in Mich.), pileus bright yellow.....*L. lutea*
2. Growing outdoors in Michigan (see americana also).....*L. cepastipes*
1. Flesh thick, margin of pileus not becoming striate..... 3
3. Lamellae becoming greenish or olive-gray in age, spore deposits olive green.....*L. molybdites*....
3. Lamellae not becoming greenish or olive gray, spores not olive green.. 4
4. Cuticle usually remaining smooth, pileus white to dull white, often smoky on disc.....*L. naucina*
4. Cuticle rupturing, cap colored, not appearing white or whitish when young..... 5
5. Spores 12—15 × 7.5—10 μ.....*L. procera*
5. Spores less than 12 μ long..... 6
6. Caps becoming dingy red in age, when bruised or when dried, cuticle fibrillose.....*L. americana*
6. Caps staining dull brown when injured, cuticle hymeniform .....*L. racodes*

LEPIOTA LUTEA (Bolt.) Quél. *sensu* Lange

Pileus 3–6 cm. broad, very fragile, campanulate, becoming broadly conic to nearly expanded-umbonate, umbo prominent, surface covered by fine fibrillose (almost powdery), often recurved squamules which are easily removed, disc smooth or rough and breaking up into scales only at maturity, rimosestriate at margin, "lemon chrome" to "picric yellow", disc often "yellow ochre"; flesh very thin, odor and taste not distinctive.

Lamellae free from stipe but attached to a ring, crowded, pale yellowish white, edges bright lemon yellow, fimbriate under a lens.

Stipe 4–8 cm. long, 1.5–5 mm. thick, enlarged to base and 6–8 mm. thick, hollow, stuffed, covered by a bright lemon yellow powder, darker and orange-yellow on base, base nearly glabrous in age and pale yellowish white; annulus present on upper third of stipe, cottony fibrillose, bright lemon yellow, probably moveable, evanescent.

Spores 8–11 x 5–7 μ, ovoid-ellipsoid, white in mass, brown in Melzer's reagent, walls thick, germ pore evident; basidia clavate, 4-spored;

gill trama interwoven, the hyphae somewhat inflated; cheilocystidia 24–80 x (5) 9–21 μ, fusoid-ventricose with obtuse apex, mucronate or with a more elongated neck, sometimes narrowly fusiform; pleurocystidia none; pileus trama floccose, hyphae about 5 μ in diam., cuticle cellular, the cells irregular and sometimes ± Y-shaped, mostly subglobose or short-cylindric and readily separable, often borne in ± upright chains, cells 7–28 μ in diam.

Singly or in clusters in orchid pots or under *Monstera deliciosa* in greenhouses in winter.

Observations: Dried caps are quite characteristic, they look powdery, the flesh is thin and striations prominent.

LEPIOTA CEPASTIPES (Sow. ex Fries) Kummer

Pileus 2–8 cm. broad, thin, soft, oval, apex truncate when young, becoming campanulate-expanded, obtuse, finally umbonate, cuticle at first breaking into fine, white, mealy warts, becoming fibrillose-scaly, long-striate, or striate on margin only, margin subrimose, disc usually smooth but in some old caps it may be covered with fine scales also, white over all at first and as the cuticle starts to break, toward maturity the fibrils becoming brownish to fawn or purplish drab over the white flesh, when bruised sometimes becoming straw yellow (color change especially marked in young specimens), no change apparent when cut; flesh thin, white, odor and taste mild.

Lamellae remote from stipe, crowded, thin, narrow, white, becoming dingy, edge even and pruinose.

Stipe 4–12 cm. long, 3–6 mm. thick, flexuous, somewhat fusiform-ventricose when young, slightly bulbous with a short point in mature specimens, smooth or only faintly pruinose, white at first, becoming delicately flesh-tinted, often turning straw yellow where handled; annulus rather large, thick, membranous, white, subpersistent.

Spores (6.5) 7–9 (10) x 6–7.5(8) μ, broadly ellipsoid, yellow brown in Melzer's reagent, walls thick, germ pore evident, oil drop prominent; gill trama compact, interwoven; basidia clavate, 4-spored; cheilocystidia 32–45 x 10–17 μ, fusoid-ventricose, often mucronate and sometimes with a long slender neck; pleurocystidia none; cuticle of pileus of irregularly disposed pilocystidia in a more or less erect position but not forming a palisade, pilocystidia 45–90 x 9–11 μ, sometimes somewhat swollen at base, walls moderately thickened, ends rounded.

Cespitose on sawdust or rich soil, June, July, August.

Observations: This species may remind one of some of the Coprini when first seen, it is very fragile and does not remain long in good condition. The pigment in the cuticle is soluble in water and KOH mounts of revived material.

LEPIOTA MOLYBDITES (G. Meyer ex Fr.) Sacc. var. MARGINATA Smith

Pileus (6) 10–25 (30) cm. broad, hemispheric or obtuse when young, becoming obtusely campanulate or broadly convex, in early stages covered by thin white membranous patches of the almost rudimentary universal veil, later with crustose scales, often coarsely areolate-scaly along the margin at the time the veil breaks, cuticle at first "pale

pinkish buff" to "light pinkish cinnamon", the scales sometimes darkening to almost fuscous in age if they persist, flesh showing whitish where the cuticle is torn away; flesh thick, (up to 2 cm.) soft and fibrillose, white, changing to sordid reddish when cut or bruised, odor faint and slightly pungent, taste slight, not distinctive.

Lamelle remote from stipe, close, broad (up to 2 cm.), at first white to creamy white, becoming greenish and in age olive-gray, or sometimes rather dark sordid olive brown, edges eroded, margined pale to dark fuscous in buttons, blackish in age.

Stipe 14–25 cm. long, 2–2.5 cm. thick at apex, enlarged to a clavate base 4–6 cm. in diam., glabrous, smooth to slightly powdered above the annulus, whitish at first and becoming tinged pallid incarnate-cinnamon above and sordid incarnate-avellaneous below; annulus large, firm, superior at first, double, becoming moveable, whitish and glabrous on upper side (except when covered with spores), zoned or scaly underneath, edge usually lacerate.

Spores "glaucous green" in mass, greenish-hyaline when mounted in KOH, dark reddish brown in Melzer's reagent, (9) 10–12.5 × 6.5–8 μ, subovoid, wall thickened, apex obscurely truncate, germ pore present; basidia four-spored, 36–44 × 9–12.5 μ, clavate, hyaline in KOH, yellowish in Melzer's reagent, cheilocystidia abundant, 42–68×9–15 μ, clavate to fusoid-ventricose, thin-walled, contents pale to dark fuscous, the pigment persistent in KOH; pleurocystidia none; gill trama interwoven, floccose, hyaline in KOH, scarcely yellow in Melzer's reagent, cuticle of narrow, very compactly interwoven hyphae, but over the disc these more or less upright but not forming a typical turf; clamp connections none.

In lawns, on the ground, in gardens, etc., usually forming a fairy ring; August and September. All collections are from the southern part of the state. Var. MARGINATA is known only from the type collection. Var. MOLYBDITES is the commonly encountered variety and differs only in having non-marginate gills.

Observations: This large, conspicuous Lepiota is readily identified by its green spore deposit and is well known under the name *L. morgani*. Since this species is poisonous to many people and the color of the deposit is the only reliable identifying character, a spore deposit should always be made when one is considering eating similar easily confused lepiotas or members of the genus Agaricus.

LEPIOTA NAUCINA (Fr.) Quél.

Pileus 4–8 (12) cm. broad, subglobose to ovoid young, becoming convex and finally broadly convex, or with a slight obtuse umbo, surface smooth or only rarely broken up into scales, unpolished to appressed fibrillose, the margin usually fibrillose-tomentose, usually smoky gray over the disc, white to dull white or sometimes tinged very pale buff elsewhere when young; flesh thick, white, rather firm, odor slight and not distinctive, taste mild.

Lamellae approximate to the stipe at first, becoming more distant in age, crowded, broad, broadest near the cap margin, white at first, slowly changing to sordid grayish vinaceous, when dried dingy vinaceous brown to dark avellaneous, edges slightly floccose.

Stipe (5) 7–12 (15) cm. long, (5) 6–12 (18) mm. thick at apex, equal or slightly enlarged at base, stuffed, then soon hollow, glabrous to silky below the annulus, slightly pruinose above, white throughout; annulus persistent, membranous, often collar-like around the stipe and flaring above the collar, edge double, thick, white, cottony-floccose, upper surface white and silky, lower surface pallid buff at or near the margin.

Spores 7–9 × 5–6 μ, subovoid, white in deposits, hyaline in KOH and showing a large oil drop, rusty brown in Melzer's reagent, walls thick, with a small apical lens-shaped plate; basidia 28–32 × 8–9.5, 4-spored, hyaline in KOH; cheilocystidia abundant, 28–39 (44) × 7–12 μ, some slightly fusoid-ventricose with obtuse apices, some clavate to saccate, hyaline in KOH; pleurocystidia none; gill trama interwoven, hyaline in KOH; pileus trama homogeneous, no well defined pellicle formed, some slightly enlarged hyphal cells 80–100 × 7–10 μ (usually tapered slightly to an obtuse apex) present as occasional pilocystidia.

Growing in lawns, meadows, waste land, under shrubs or trees, on compost; September and October. All collections examined were from the southern part of the state.

Observations: This is considered to be edible but care must be taken not to confuse it with some of the poisonous amanitas.

Lepiota procera (Fr.) S. F. Gray

Pileus, (6) 7–20 cm. broad, ovate becoming campanulate, convex and finally nearly plane with a low obtuse umbo covered at first with a cuticle which ruptures to form flattish scales, as the cap expands small floccose scales may be found between the large flat ones, the surface finally floccose-fibrillose, cuticle over the umbo scarcely ruptured, reddish brown or crust-brown, whitish flesh showing between scales; flesh thick, soft, white or slightly reddish; odor and taste pleasant.

Lamellae remote from stipe, broadest toward the cap margin, white, becoming faintly pinkish and at length brownish, edge floccose.

Stipe 15–40 cm. long, 8–12 mm. thick at apex, bulbous at base, tapering slightly toward the apex, readily separable from the pileus, hollow or stuffed with long, delicate fibrils, surface furfuraceous or breaking up into minute scales and allowing the white flesh to show through, scales colored like those of pileus or paler; annulus superior, moveable, lower surface scaly and concolorous with the stipe.

Spores 12.5–15 (16) × 7.6–10 μ, broadly ellipsoid, having a thick wall and an obscure apical pore, white in mass, purple brown in Melzer's reagent; cheilocystidia 20–38 × 5–12 μ, clavate to subcylindric; pleurocystidia none; cuticle of disc and large flat scales a compact turf of brown cells 30–70 μ long and 5–10 μ in diam., the terminal cell very slightly inflated and either tapered to a point or mucronate, fibrillose scales elsewhere of septate hyphae 5–15 μ wide with cross walls every 100–150 μ, the cells readily separable (thus giving rise to the sometimes noticeable powdery appearance of the cap); clamp connections present but rare.

Single to scattered or gregarious on ground, along roads, in open oak or aspen woods and edges of woods; August, September, October.

Observations: This very striking species is considered to be one of the best edible mushrooms.

LEPIOTA AMERICANA PECK

Pileus 3–15 cm. broad, ovate, obtuse or almost truncate, becoming broadly convex or nearly plane and umbonate, cuticle at first continuous, the disc dull and unpolished, at times slightly scaly, remainder ruptured into large scattered scales, in age becoming appressed fibrillose scaly to lacerate scaly, more or less striate on margin, "pinkish buff" to "tilleul buff", soon reddish or bay brown, whitish between scales when young and fresh but becoming dingy red in age or when bruised; flesh thick, very firm, white, becoming buff or reddish in age or when bruised, odor and taste not distinctive.

Lamellae at first approximate to the stipe, sometimes becoming remote and attached to a collar, horizontal to ascending, 5–10 mm. broad, broader toward the margin, thin, white, often darkening to pinkish buff in aging, edges white, fimbriate, close, 2 tiers of lamellulae.

Stipe 7–12 cm. long (4) 8–22 mm. thick at apex, clavate to subbulbous at base or at times fusiform, hollow, stuffed, staining yellowish or reddish and finally sordid reddish buff after handling, appressed silky fibrillose; annulus superior, double, rather large, flaccid, sometimes moveable and sometimes evanescent, whitish in general but often cracked into sordid patches below.

Spores 9–10.5 (12) × (5) 7–8.5 μ, broadly ellipsoid or subglobose, hyaline in water, rusty brown in Melzer's reagent, walls thick, germ pore evident; basidia 4-spored, 16–24 × 7–10 μ; cheilocystidia 19–60 × 7–21 μ, fusoid-ventricose, with or without a neck; pleurocystidia none; pileus trama compact, homogeneous, interwoven, surface only slightly differentiated, being a little more compact, the hyphae slightly inflated, 4–9 μ in diam., apex rounded, these hyphae not regularly arranged, some appressed some erect, others in between, not forming a turf; clamp connections present.

Solitary to cespitose in fields or around old stumps. August. Not common.

Observations: The whole carpophore becomes smoky red on drying, the red color is soluble in water and KOH and comes out on the slide when a mount is made. Kauffman stated that the pileus may sometimes be almost entirely white when fresh and that the gills and flesh may have a yellow tinge at first.

LEPIOTA RACODES (Vitt.) Quél.

Pileus (8) 10–20 cm. broad, obtuse to convex, becoming broadly convex to nearly plane in age, cuticle continuous, glabrous and unpolished at first, soon rupturing into coarse, recurved, concentrically arranged scales exposing the white flesh, pallid grayish to avellaneous or tinged "vinaceous fawn" at first, scales becoming dark cinnamon-brown to "bister", surface between the large scales torn into ± appressed white fibrillose scales, the margin fringed with aggregations of fibrils; flesh delicate, thick, white, becoming slightly pinkish when broken or bruised, odor and taste not distinctive.

Lamellae remote from stipe, close, broad, white, staining slightly to yellowish and then brown when bruised, edges even.

Stipe 10–20 cm. long, 1–2.5 cm. thick at apex, clavate, base up

to 5 cm. thick, stuffed with a white silky pith, glabrous and white over all, lower part staining bister; annulus thick, double, scaly underneath toward the margin, upper limb fringed, turning dark brown on underside in age.

Spores 8–10.5 × 5–6.5 μ, subellipsoid to somewhat ovoid, when first mounted having a distinct vinaceous tint, strongly pseudoamyloid in Melzer's reagent, wall thickened, lens plate small, apical; basidia 22–34 × 7–9, clavate, 4-spored; cheilocystidia 18–27 × 10–15 μ, abundant, vesiculose, clavate or mucronate, brownish to hyaline in KOH; pleurocystidia none; gill trama loosely floccose; pileus trama floccose, hyaline in KOH, cuticle a compact hymeniform layer of clavate to capitate cells 18–36 × 8–14 μ with flexuous pedicels, this layer dull brown in KOH.

Growing along roads under pine or spruce, on straw piles and in garden soil; September, October. Known from a few collections, all from southeastern Michigan; apparently it is not common.

Observations: Considered edible but not recommended because of the danger of confusing it with *L. molybdites* especially in the desirable button stage.

Subgenus Eu-Lepiota section integrellae

Key to Species

1. Pileus white at first ..... *L. rufipes*
1. Pileus brownish ..... *L. neophana*

Lepiota rufipes Morgan

Pileus 8–10 mm. broad, obtusely conic, becoming convex, pure white, chalky, becoming sordid in age, surface even or becoming somewhat rugulose when withering.

Lamellae nearly touching the stipe, close, broad, white.

Stipe 1–2 cm. long, 1–1.5 mm. thick, equal, dull flesh color, covered with white fibrils; annulus evanescent.

Spores 4 × 2.5–3 μ, ovoid, cheilocystidia slenderly clavate, 10–20 × 4–6 μ; pleurocystidia none; cuticle a hymeniform layer of nearly globose cells with pedicels, cells 15–25 μ wide.

Scattered on soil; July. Rare.

Observations: This greatly resembles *L. seminuda* in general aspect, but the hymeniform cuticle and the lack of mealiness on the cap readily distinguish it. This species is also known from France, where it may be up to 1.5 cm. broad, and in the very young stages is said to have a cobwebby, very fugacious partial veil.

Lepiota neophana Morgan

Pileus 1–3 cm. broad, obtuse to almost globose when young, becoming broadly conic to almost plane, with or without a slight umbo, cuticle continuous at first, remaining smooth on disc, sometimes splitting radially on the margin and showing the white flesh, not truly scaly but the cuticle soon rupturing into small irregular areolae or furfuraceous patches at least toward the margin, disc near army brown, remainder wood brown or having a faint vinaceous tint or "avellane-

ous"; flesh very thin, fragile, white, unchanging, odor and taste not distinctive.

Lamellae approximate to the stipe, crowded, about 2 mm. broad, white at all times, edges slightly uneven, 2 tiers lamellulae.

Stipe 2.2–5 cm. long, 2.5–4 mm. thick, slender, subequal, glabrous except for faint white fibrils at the apex, loosely stuffed becoming hollow, white over all at first but becoming brownish vinaceous or sordid at least below; annulus median to superior, bandlike, persistent and well constituted, white above, colored like the cap below; base of stipe with numerous adhering white rhizomorphs.

Spores 3.5–5.5 × 2.2–2.8 μ, cylindric to nearly ovoid, walls smooth, staining pale brown in Melzer's reagent in which the spores tend to adhere together; cheilocystidia basidium-like, 17–30 × 8–12 (15) μ; pleurocystidia none; gill trama very compact, interwoven but appearing nearly parallel; pileus trama floccose; cuticle a hymeniform layer of puriform cells 20–42 × 5–18 μ; clamp connections none.

Under spruce; June–Sept.

SECTION CLYPEOLARIAE

KEY TO SPECIES

1. Pileus 1—3 cm. broad, vinaceous buff, spores 11—15 μ long..... *L. floralis*
1. Pileus 2.5—7 cm. broad, chestnut or cinnamon brown to yellowish, spores 12.5—18 μ long..... *L. clypeolaria*

LEPIOTA CLYPEOLARIA (Fries) Quél.

Pileus 2.5—7 cm. broad, narrowly ovoid to obtusely campanulate at first, expanding to broadly campanulate or convex, sometimes nearly plane and sometimes with an obtuse umbo, the margin at times slightly recurved in age, surface at first appressed fibrillose, soon ruptured into fibrillose scales or patches, the scales more widely separated over the marginal area, disc usually remaining appressed fibrillose, dark chestnut to cinnamon brown over the disc and paler, usually ochraceous tawny toward the margin, sometimes the entire cap yellowish; flesh white or pale yellowish near the surface, thin, odor mild to slightly pungent, taste not distinctive.

Lamellae approximate to the stipe, close, narrow (2—4 mm.). edges even, 2 tiers of lamellulae.

Stipe 4—10.5 cm. long, 2.5—8 mm. thick, equal or nearly so, hollow, fragile, appressed silky fibrillose above the annulus, sheathed below with a dense floccose–fibrillose covering which is soon ruptured into scales or zones and is eventually somewhat evanescent, white or whitish toward the apex, more or less sordid yellowish brown over the lower portion, or in age sordid yellowish over all.

Spores 12.5—18 (20) × 4—5.5 μ, fusiform, white in mass, yellow brown to dark brown in Melzer's reagent; basidia 28–36 × 4–14 μ, 4-spored, hyaline, thin-walled, usually smooth but at times the apices minutely echinulate; cheilocystidia small, basidium-like, slenderly clavate or narrow fusoid-ventricose, 16–24 × 4–8 μ, gill trama of enlarged, somewhat interwoven hyphae, subhymenium cellular in section; pileus trama of hyaline, interwoven hyphae 9—12 μ in dia., having clamp connections at the cross walls; cuticle composed of more

or less upright hyphae with brown, nearly smooth walls, the terminal cells with rounded apices and flexuous walls, no clamp connections at the basal septum, cells of an even diameter except near the base (10—12 μ), end cells 100—250 μ long, arranged in fascicles to form the scales.

On the ground, or in humus under hardwoods or in mixed woods, sometimes in swamps; August to September. Quite common throughout the state.

Observations: The fusoid spores make this one of the easiest species to identify. Quite pale forms with the stipe only slightly scaly are often found in Michigan. Kuhner and Romagnesi (1953) have described 3 varieties in addition to the typical one. It is likely that some of these occur here.

Lepiota floralis (Berk. & Rav.) Sacc.

Pileus 1–3 cm. broad, convex, plane or with an upturned margin in age, dry, disc dull and remaining smooth, cuticle breaking up into slightly recurved fibrous scales near the margin, margin beautifully appendiculate at first, "vinaceous buff" at first, disc may be slightly darker; odor and taste not distinctive.

Lamellae close to the stipe, rather distant, moderately broad, white or pallid in age.

Stipe 1–3 cm. long, 2 mm. thick, equal, hollow, rather tough, covered by a sheath of loose, torn fibrils up to the annular zone, glabrous or with scattered fibrils in age; annulus apical, ragged-fibrillose, near "avellaneous" or "wood brown" beneath.

Spores 11–15 × 4–4.5 μ, fusiform, walls thick, rusty brown in Melzer's reagent; cheilo- and pluerocystidia none, gill edges fertile; gill trama compact, subparallel; cuticle of pileus of appressed hyphae 9–19 μ wide, in places this layer pushed upward and ruptured by fascicles of pilocystidia 10–20 × 6–10 μ, these clavate, very slender and often flexuous at the base; clamp connections present.

Sandy hillside: August. One collection.

Section Stenosporae

Key to Species

1. Cuticle of disc and scales a hymeniform layer of pyriform cells.....*L. cristata*
1. Cuticle of elongate pilocystidia..... 2
   2. Surface of pileus having concentric rows of scales, white flesh conspicuous between them, stipe 7—20 mm. thick, pleurocystidia present .....*L. cortinarius*
   2. Surface of pileus more evenly colored, white flesh showing only in age, stipe 1.5—4 mm. thick, pleurocystidia lacking.....*L. acerina*

Lepiota cristata (Fr.) Kummer

Pileus 1.5—5 cm. broad, thin, ovate, becoming broadly convex to nearly plane, obtuse or umbonate, cuticle at first continuous, rupturing into concentric rings of small scales with the white to pale cream flesh conspicuous between them, disc "mikado brown" to "russet", scales toward margin paler and reddish brown to "pinkish buff", margin often devoid of cuticle; flesh very thin, fragile, white, unchanging, odor strong and disagreeable, taste subfarinaceous to disagreeable.

Lamellae rather close to stipe, crowded, narrow to subventricose, 3—4 mm. wide, white, unchanging, edges minutely crenulate.

Stipe 3—7 cm. long, 2—5 mm. thick at apex, slender, equal, hollow or loosely stuffed, context pinkish, surface glabrous and shining or sparcely silky fibrillose, whitish above, pale pinkish tan or dingy lavender below; annulus superior, small, evanescent, white.

Spores 5.5—7 × 3—4 μ, wedge-shaped, truncate at broadest end; cheilocystidia 12—25 × 5—10 μ, inflated; pleurocystidia none; cuticle of pileus and the scales a compact hymeniform layer of pyriform cells about 50 μ long and 10—17 μ wide, between the scales the surface is of colorless appressed hyphae.

Solitary or gregarious, growing on soil, humus, sand, rotten logs, in grass, between rocks or in woods. June, July, August. Common throughout the state.

Observations: A few collections with an agreeable or fragrant odor have been made. These appear to differ in no other respects.

LEPIOTA CORTINARIUS Lange

Pileus 3—10 cm. broad, convex becoming nearly plane and the margin often irregularly elevated, disc solid brown, remainder of surface covered with small, concentrically arranged fibrillose scales, the white flesh showing through in most, but in some the surface almost evenly colored, scales cottony-fibrillose under a lens, tawny to ochraceous tawny, flesh splitting radially fairly readily; flesh thick, white, firm, no distinctive odor or taste.

Lamellae remote from stipe at least in age, crowded, becoming subdistant, thin, subventricose, 3—5 mm. wide, having gilvous stains in age, edge even, 2 tiers lamellulae.

Stipe 3—9 cm. long, 7—20 mm. thick, enlarged into a small, flat, marginate bulb at base, glabrous at apex, fibrillose to fibrillose-scaly below, scales similar to those of pileus, concolorous; annulus cobwebby and evanescent.

Spores 7.5—10 × 3—4 μ, oblong—ovoid, truncate at apicular end, dark brown in Melzer's reagent; basidia 19—24 × 7.2 μ; cheilocystidia 20—25 × 7.5—12 μ, clavate; pleurocystidia few, scattered, projecting only slightly beyond the hymenium, capitate with a slender pedicel and 28—40 × 12—19 μ or sometimes slenderly fusoid and about 7—8 μ, both kinds hard to see; gill trama compact, subparallel; cuticle of pileus of brown-walled pilocystidia 120—220 × 10—18 μ, walls thick, flexuous at base, pilocystidia erect or so closely appressed the layer appears interwoven and requires teasing out before the elements can be distinguished; clamp connections present.

On needle carpets under spruce and in cedar swamps. September and October.

Observations: Rain-washed specimens of *L. acutaesquamosa* may resemble specimens of *L. cortinarius* in appearance but the latter can be readily distinguished by the pilocystidia, capitate pleurocystidia and the stains on the gills.

LEPIOTA ACERINA Peck

Pileus 1—5 cm. broad, convex or obtusely conic, becoming nearly

plane or with an elevated margin, umbo obtuse, margin recurved in a few specimens, sometimes fringed with veil remnants, surface dry, innately fibrillose-squamulose, disc not ruptured, resembling the pile of a rug or with fine erect, pointed scales, toward the margin usually covered with fibrils, these often aggregated into scales but white flesh seldom showing except in age, disc dark chestnut brown ("russet" or "cinnamon brown") paler toward the margin (tawny, ochraceous tawny"), often even paler in age, scales appearing cobwebby under a lens; flesh moderately thick on disc, thin elsewhere, soft, white to pale buff or sordid, odor and taste mild to somewhat pungent.

Lamellae approximate to stipe, close to crowded, thin, moderately broad, broadest near the stipe, whitish young, becoming "pinkish buff", "pale ochraceous buff" or "avellaneous" in age, sometimes with sordid brownish spots in age, edges minutely fimbriate, whitish or brownish.

Stipe 2—10 cm. long, 1.5—5 mm. thick at apex, equal above a slight bulb, hollow or stuffed with a silky pith, nearly glabrous or silky fibrillose above, sparsely fibrillose or with a few fibrillose scales below, scales colored like those of the pileus, flesh whitish above, tinged dull purplish brown below; no definite annulus formed, the pileus and stipe joined at first by the evanescent, cobwebby, white partial veil.

Spores (6.5) 8—11 × 3—4 μ, oblong or narrowly ellipsoid, obliquely apiculate and truncate at the broader end, smooth, white, rusty brown in Melzer's reagent; basidia 4-spored, clavate; cheilocystidia 20—36 (50) × 5—10 μ, clavate; pleurocystidia none; gill trama compact, interwoven; cuticle of elongate pilocystidia 72—210 × 9.6—17 μ, mostly erect, often aggregated into pointed scales; clamp connections none.

Scattered to gregarious around decayed stumps, on wood or mossy banks. July, August, September. Common.

Observations: This is readily distinguished from the other common small brown Lepiotas by its truncate spores.

SECTION MICACEAE

KEY TO SPECIES

1. Pileus staining reddish when bruised or in age ..... *L. rufescens*
1. Pileus not staining red as above 2
   2. Pileus and stipe typically covered with a very copious powder, often appearing warty, umbo broad, flesh rather thick on disc, well developed specimens rather fleshy 3
      3. Gill faces having pleurocystidia ..... *L. cystidiosa*
      3. Gill faces lacking cystidia ..... *L. petasiformis*
   2. Powder not as copious as in above, pileus plano-convex, not having a prominent umbo, flesh thin, never appearing fleshy 4
      4. Pileus pinkish to flesh color ..... *L. seminuda*
      4. Pileus white or dingy ..... *L. seminuda* var. *pusillomyces*

LEPIOTA RUFESCENS Lange

Pileus (0.4) 1.5—2.5 cm. broad, conic to broadly convex, covered by a dense coating of evanescent, mealy pyramidal scales, becoming evenly powdery or granular in age, or at times appearing smooth to the naked eye and finely fibrillose under a lens, margin at first appendi-

culate with pulverulent patches of veil tissue, whitish, sordid cream or "light pinkish cinnamon" when fresh, becoming grayish and changing to reddish or dull ferruginous when touched or in age; flesh fairly thick, whitish, slowly rufescent where cut, taste bitter, odor not distinctive.

Lamellae almost touching the stipe, close, broad, white becoming sordid brownish when dried, often staining reddish on edges when touched, 3 tiers lamellulae.

Stipe 2—4 cm. long, 1.5—4 mm. thick, tubular, enlarged somewhat at base, covered at first with powdery material like the pileus, concolorous with pileus at base, rufescent or sordid where handled or cut; annulus not well defined, evanescent, consisting of a zone of whitish or sordid cream evanescent pulverulence.

Spores 4—5 × 2.5 μ, narrowly ellipsoid, hyaline in Melzer's reagent; basidia clavate, short, 4-spored; cheilocystidia small, 25—30 × 6—12 μ, abundant, fusoid-ventricose, often with a neck, sometimes capitate and sometimes with a globose neck surmounted by a needle-like projection, sometimes with a yellowish content when revived in KOH and sometimes having a yellowish globular incrustation, gill edge yellowish when revived; pleurocystidia rare or scattered, 25—35 × 7—12 μ, fusoid ventricose, capitate or with an obtuse apex, in fresh specimens filled with a granular material, arising from slender hyphae in the subhymenium which have a similar content; surface of cap and stipe of thin-walled globose cells 13—40 μ in dia.

On humus. July. Not common.

Observations: This is readily distinguished from *L. seminuda* by the coarser appearance of typical material, the color change and the presence of pleurocystidia. In appearance it is quite similar to *L. petasiformis* and *L. cystidiosa* but neither have the characteristic red color change. *L. heterei* Boud., known in Europe and, so far as I know, not yet reported in this country, also exhibits a similar color change. However, it does not have pleurocystidia, is white at first and turns to ferruginous chocolate upon standing after being collected.

Lepiota cystidiosa A. H. Smith

Pileus (2) 3—9 cm. broad, obtusely conic to convex when young, becoming broadly convex to plane in age, occasionally remaining umbonate, the margin sometimes undulate or wavy, surface entirely covered at first by conic, powdery warts, soon becoming merely granulose to pulverulent as the warts break up, occasionally nearly glaborous in age, margin at first delicately appendiculate with soft powdery masses of veil tissue which soon fall off, warts and powder "pinkish buff" to "pale pinkish buff", the white flesh showing until late maturity, in age somewhat brownish buff or "wood brown" over all; flesh soft and dry, white, slowly changing to sordid buff (not at all reddish)when cut or bruised, odor sharp but faint and easily overlooked, taste bitterish.

Lamellae almost touching the stipe, very close, broad (8—12 mm.), broadest at the stipe and tapering evenly to the margin, pure white at first, soon cream-color and becoming "wood brown" (dull brown) like the pileus, often stained dark sordid brown and occasionally dark purple-brown over all when very old, 2—3 tiers lamellulae.

Stipe 4—8 cm. long, 3—7 mm. thick, equal or the base slightly bulbous, hollow, rather fragile, context silky, surface silky above, covered by dense powdery masses up to the powdery zone left by the broken veil; annulus seldom formed or soon evanescent, veil remnants concolorous with the powdery covering of the pileus.

Spores 4—4.5 × 2.5 μ, ellipsoid or the base slightly truncate, smooth, hyaline, pale yellowish to tawny-brown in Melzer's reagent; basidia 4-spored, cheilocystidia and pleurocystidia similar, pleurocystidia abundant, usually fusoid with acute apices or ventricose-subcapitate, the head 3—5 μ in dia., in water mounts usually with a slight incrustation and a highly refractive golbular content (probably of oil droplets) 25—42 × 7—12 μ (20—30 × 8—12 μ in saccate cystidia); gill trama homogenous, nearly hyaline in Melzer's reagent; pileus trama homogenous, cuticle of thin-walled globose cells 15—40 μ in dia.

On low ground or in humus, sometimes in muck under Impatiens. August, September.

Observations: This species is well characterized by its very copious powder, somewhat fleshy consistency, lack of a quick color change and the presence of abundant pleurocystidia.

Lepiota petasiformis Murrill

Pileus 3.6—4 cm. broad, broadly convex, frequently hat-shaped, the umbo broad and obtuse or conic, surface densely powdery, powder thick, often forming warts or scales at least when young, easily removed, pale pinkish buff; flesh thick on disc, abruptly thin, white, unchanging, odor and taste farinaceous.

Lamellae approximate to the stipe, very crowded, white, not darkening in age or on drying, 3 tiers of lamellulae.

Stipe 2—3.3 cm. long, 4—5 mm. thick, equal, decorated with patches similar to those of the pileus, no definite annulus.

Spores 4—5 × 2.5—3 μ, nearly oblong, pale rusty brown in Melzer's reagent; basidia 25—30 × 5—7 μ, clavate, 4-spored; cheilocystidia 20—40 × 7.5—9.6 μ, clavate; pleurocystidia none; gill trama compact, subparallel; cuticle of globose cells 12—50 μ in dia., walls pale yellow; clamp connections none.

On ground in woods, September. Rare.

Observations: The other species with which this might be confused are *L. cystidiosa* and *L. rufescens*. However, they both have pleurocystidia and the latter has a pronounced color change to red. All three of these tend to have more copious powder when young and a more fleshy aspect than the more fragile appearing *L. seminuda*.

Lepiota seminuda (Lasch) Kummer

Pileus 1—2.5 (3) cm. broad, convex to nearly plane, covered with a dense powdery coating at first aggregated into fine warts but in age evenly distributed, margin at first appendiculate, surface becoming nearly glabrous and micaceous glistening in age, "hydrangea pink", often whitish along the margin; flesh thin but firm, white, tapered evenly to the margin, taste in some faintly like that of *L. cristata*, never strong, odor not distinctive.

Lamellae approximate to the stipe, close, broad and ventricose (3 mm. ±), white, unchanging, edges even, 1 tier of lamellulae.

Stipe 2—4 cm. long, 1.5—3 (4) mm. thick, equal above and indistinctly bulbous at base, hollow, at first covered by a coating of powder up to the evanescent annular zone, in age only faintly powdery or cottony, white above, "hydrangea pink" or darker at base, the color often obscured by the surface powder.

Spores 4—5 × 2.5—3 μ, ellipsoid, pale brown in Melzer's reagent; basidia 10—15 × 4—5 μ, 4-spored, clavate; gill trama compact, subparallel; pleuro- and cheilocystidia lacking; cuticle of globose, thin-walled cells 20—30 μ in dia.

Gregarious on soil, usually in woods, August to October.

Observations: A number of small pinkish to whitish pruinose Lepiotas have been described. It seems likely that some should be referred to this species. *L. cristatella* Peck in particular, does not seem to differ significantly but further work is needed in this group before definite conclusions can be drawn.

Lepiota seminuda Fr. var. **pussillomyces** (Peck) n. comb.

Similar to the typical variety described above and differing by its usually smaller size and white color of the cap. The pileus is usually 4—15 mm. broad. Specimens referred to *L. hemispherica* Murrill and *L. seminuda* forma *minima* Lange probably are the same as this variety.

In bogs or woods. August, September.

SECTION ECHINATAE

KEY TO SPECIES

1. Pileus 4—8.5 μ wide, stipe 6—11 cm. long, spores 6.5—9 μ long . . . *L. acutaesquamosa*
1. Pileus 1—4.5 cm. wide, stipe 2—6 cm. long, spores 3—5 μ, long . . . . . *L. asperula*

LEPIOTA ACUTAESQUAMOSA (Weinm.) Kummer

Pileus 4.7—8.5 (10) cm. broad, obtuse to convex at first, becoming broadly convex to nearly plane, sometimes with an obtuse umbo, surface dry, at first covered by conspicuous cottony fibrillose scales or warts, these squarrose on disc and appressed toward the margin, somewhat evanescent and the disc merely appressed fibrillose at times in age, the fibrillose cuticle dark avellaneous to rich cinnamon ("wood brown" to "hair brown", tinged "cinnamon" or "Sayal brown"), the whitish ground color usually showing through toward the margin; flesh thick, 4—10 mm. thick at disc, tapering evenly to margin, firm, white, taste mild, odor pungent or lacking.

Lamellae crowded, thin, narrow (4—8 mm.) sometimes forked, white, edges usually eroded.

Stipe 6—11 cm. long, 8—12 mm. thick at apex, clavate to somewhat bulbous and up to 15—22 mm. thick at base, hollow or stuffed with a white silky pith, flesh white to yellowish, surface appressed silky-fibrillose or nearly glabrous above, lower portion more fibrillose and nearly concolorous with the pileus; annulus median to superior, cottony fibrillose and often evanescent, the margin colored like the fibrils of the cuticle.

Spores 6.5—9 (11) × 2—3.5 μ, subcylindric, hyaline to very pale yellowish in Melzer's reagent; basidia 4-spored; cheilocystidia 20—25 × 7—10 μ, clavate, hyaline, thin-walled; gill trama parallel; pileus trama compactly interwoven, hyaline; cuticle of short cylindric to nearly globose cells which separate readily and are intermingled with a mass of filamentous hyphae 2.5—8 μ in dia., these more or less radially arranged, the walls brown and smooth or slightly roughened; clamp connections abundant.

Growing on soil, in humus, on debris or leaves in woods. July, August, September. Common.

Observations: Some authorities have recognized two species, *L. acutaesquamosa* and *L. friesii*. In the latter the gills are frequently forked. In Michigan so many intermediate conditions in regard to this character have been found that it does not appear justifiable to recognize *L. Friesii* as more than a mere form—if it deserves recognition at all. *L. cortinarius* is the most closely related species and is likely to be mistaken for specimens of *L. acutaesquamosa* in which the warts are lacking. In *L. cortinarius*, however, the gills soon develop sordid brownish to yellowish brown stains, it never has short-cylindric cells in the cuticle and its spores are truncate.

Lepiota asperula Atk.

Pileus 1—4 cm. broad, ellipsoid to convex, becoming obtuse and nearly plane, margin often arched or recurved and undulate in age, surface covered by pyramidal, cobwebby scales which are denser on the disc, scales or warts near army brown or "verona brown", those on disc usually persisting, the others often evanescent, when warts are gone the surface covered by a thin vinaceous-brown, pruinose-fibrillose layer over the pallid flesh, margin at first appendiculate with vinaceous brown patches; flesh thin, white, at times becoming pallid in age; odor faintly of cinnamon, taste mild or farinaceous.

Lamellae close to the stipe, rather crowded, white, becoming creamy or faintly yellowish flushed in age, edges on mature specimens somewhat eroded.

Stipe 2—4.5 cm. long, 2—4 mm. thick at apex, enlarged at base, fragile, hollow or stuffed with a white fibrillose pith, surface whitish and silky above, the lower ¾ clothed with an almost powdery tomentum which is concolorous with that of the pileus and which may be aggregated into evanescent warts or zones, when warts are gone the base merely fibrillose, in age becoming vinaceous brown at least at the base; annulus not well formed, consisting merely of a fibrillose zone.

Spores 3—5 × 2—3 μ, oblong or rounded ellipsoid, yellowish brown in Melzer's reagent; cheilo- and pleurocystidia lacking; cuticle of pileus of pyramidal patches of loosely arranged, readily separable, short-cylindric and globose cells as well as longer, somewhat appressed hyphae, the walls brownish.

On rich humus. August and September.

Observations: Several species are quite similar to this and some or all may be identical. A careful study at the monographic level of *L. hystrix* Moller-Lange, *L. echinacea* Lange, *L. eriophora* Peck, etc., is needed before this group is well understood.

SECTION OVISPORAE

KEY TO SPECIES

1. Cuticle of pileus of more or less erect pilocystidia, annulus not usually well formed, if present fibrillose and evanescent, stipe with floccules or scales.. 2
1. Cuticle of pileus of appressed radial hyphae, annulus membranous, well constituted, stipe glabrous to fibrillose, not truly scaly..... 6
2. Pileus with reddish to vinaceous tints.....*L. subincarnata*
2. Pileus not colored as above..... 3
3. Pileus cream color or pinkish with a light blue zone toward the margin .....*L. cyanozonata*
3. Pileus brown to blackish brown..... 4
4. Cheilocystidia lacking, stipe rufescent below.....*L. umbrosa*
4. Cheilocystidia present..... 5
5. Scales on pileus brownish black, stipe 4–5 mm. thick.....*L. felina*
5. Scales chestnut brown or paler, stipe 4—15 mm. thick .....*L. fuscosquamea*
6. Pileus exhibiting a quick and distinct color change when touched or bruised.....*L. roseotincta*
6. Pileus not exhibiting a quick color change..... 7
7. Pileus olive or greenish gray.....*L. olivacea*
7. Pileus not olive or greenish gray..... 8
8. Pileus with some shade of pink or red..... 9
9. Pileus delicately pink, often white toward the margin.....*L. rubida*
9. Pileus more strongly colored, coral, red, salmon, rose lilac, etc., disc more colorful....*L. rubrotincta*
8. Pileus lacking shades of pink or red..... 10
10. Cap surface covered with pale yellow scales, buttons sulfur yellow.....*L. alluvinus*
10. Pileus and buttons not yellow..... 11
11. Pileus white over all.....*L. pulcherrima*
11. Disc brownish remainder of pileus whitish .....*L. miamensis*

LEPIOTA SUBINCARNATA Lange

Pileus 1—3 cm. broad, ellipsoid when young, having an obtuse umbo and plane or arched at the margin when mature, surface covered with pointed, erect, fibrillose scales on the disc and with small, appressed, spotlike scales toward the margin, or merely fibrillose, margin appendiculate at first, becoming a bit excoriate later, scales on disc reddish, elsewhere "light vinaceous cinnamon", the fibrils pale vinaceous cinnamon; flesh thin, soft, white, slightly reddish under the umbo when cut, taste mild, odor slightly fragrant.

Lamellae approximate to the stipe at first, becoming remote, moderately close, broad (about 4 mm.), oval in outline or nearly equal, white, becoming creamy in age, unspotted, 2—3 tiers of lamelluae.

Stipe 3—6 cm. long, 2—4 mm. thick, equal, solid or with a very fine stuffed tubule, whitish but slowly rufescent and finally sordid brownish over all, surface at first covered with ragged, whitish patches of fibrils or fibrillose zones up to the superior evanescent, fibrillose annulus, silky and at first pruinose above the annulus.

Spores 5—6 × 3 μ, ellipsoid, pale rusty brown in Melzer's reagent, wall thick; cheilocystidia fusoid or basidium-like, 12—25 × 6—9 μ; pleurocystidia none; cuticle of very long, slender, partially appressed, brownish, thick-walled pilocystidia up to 300 μ long and 10—12 μ wide,

narrowed to the flexuous base, obtuse at apex; clamp connections present.

Under Collinsia, August. Rare.

Observations: This attractive little species was described from woods in Denmark where it was said to be rare. Our specimens seem to be identical except for a slightly more vinaceous cast.

Lepiota cyanozonata Longyear

Pileus 1—1.8 cm. broad, conic-convex to expanded, broadly umbonate, thin except on disc, fibrillose when young, soon glabrous, slightly uneven on margin, cream-colored or pinkish white with a narrow zone of light blue near the margin, becoming brownish tan when dry; flesh white, becoming brownish when bruised, odor and taste not recorded.

Lamellae not crowded, thin, soft, whitish becoming dingy brown on drying.

Stipe 2—3 cm. long, 2 mm. thick, equal, narrowly fistulose, minutely silky at apex, squamulose below, whitish.

Spores 6—8 μ, globose, smooth, hyaline.

On decaying sticks on the ground in the woods.

Observations: The above information is from Murrill's account of this species which was described from Michigan by Longyear. I have not seen any specimens and the micoscopic characters are not well known. The blue zone near the margin of the pileus should readily characterize the species.

Lepiota umbrosa Morgan

Pileus 1.5—2.5 cm. broad, fleshy, ovoid to campanulate and expanded, subumbonate, radiate fibrillose, cuticle tawny brown, darker at center, slightly parted into minute scales at maturity, fibers on umbo often acutely convergent, white under the fibrils; flesh thin, white.

Lamellae approximate to stipe, close, rather narrow.

Stipe 4—5 cm. long, 1—4 mm. thick, subequal above the bulb, hollow, fibrous-stuffed, surface white and glabrous above the annulus, white fibrillose scaly below, rufescent under the fibrils and having scattered tawny scales or these lacking; veil flocculose, evanescent.

Spores 5—6 $\times$ 3.5—4 μ, oblong-ellipsoid, rusty brown in Melzer's reagent, cheilo- and pleurocystidia none, gill edge fertile; basidia 4—7.2 μ wide, clavate, 4-spored; cuticle of upright patches of pilocystidia 140—180 μ long which form pointed scales, at base of scales are short pyriform cells arranged in a somewhat irregular fashion, not forming a palisade.

On sandy soil: August, September. Not common.

Lepiota felina ss. Kuhner & Romagnesi

Pileus 1.5—3 (5) cm. broad, obtuse or plane with a slight umbo, disc covered with suberect, brownish black ("mummy brown") scales, surface toward the margin with scattered, sublacerate, brownish

black to cinnamon brown scales, white flesh conspicuous; flesh white, unchanging, brittle, odor faintly fragrant, taste mild.

Lamellae approximate to the stipe, close to subdistant, moderately broad, tending to stain sordid brownish.

Stipe 4—5 mm. thick, slightly enlarged below, stuffed to hollow, having scattered patches of the universal veil below; annulus distant to median, subfibrillose, lower surface having scales concolorous with the disc.

Spores 6—7.5 × 3—4 μ, ovoid—ellipsoid, walls thick, no germ pore, rusty brown in Melzer's reagent; basidia clavate, 18—21 × 5.6—7.2 μ, 4-spored; cheilocystidia 10—13 × 4—6 μ, cylindric to slenderly fusoid, sometimes with a knoblike end; pleurocystidia none; gill trama compact, interwoven; pileus trama loosely floccose; cuticle of fascicles of brown-walled pilocystidia up to 300 μ long and 7—11 μ wide, the longer ones often becoming more slender near the tip, at base of fascicles are numerous short, pyriform or clavate cells; clamp connections present.

Gregarious under conifers, on old logs or debris. August, September and October.

Observations: The concept adopted here is closest to that of Kuhner and Romagnesi (1953). There have been many different concepts published. That of Kauffman (1918) was later changed by him to apply to *L. fuscosquamea*. Further clarification at the monographic level is needed for this complex.

Lepiota fuscosquamea (Peck) Sacc.

Pileus 3—6 (8) cm. broad, obtuse with an appressed margin, expanding to broadly conic, plane and umbonate, or the margin uplifted, often splitting, cuticle ruptured into more or less concentric rings of coarse, subtomentose or floccose scales, the disc usually unruptured, margin often appendiculate with micaceous, buff fibrils, scales chestnut brown or bone brown at first, gradually paler and in old caps wood brown to avellaneous, white flesh showing between scales; flesh thin and dry, white, unchanging, odor and taste mildly farinaceous.

Lamellae close to stipe, white, narrow, often with brown spots in age.

Stipe 6—9 (12) cm. long, 4—15 mm. thick, enlarged below to a slight bulb, hollow, whitish and cottony fibrillose on surface above, clothed below with floccose or fibrillose patches and zones concolorous with pileus; annulus scarcely formed, inferior or median, very slight and evanescent.

Spores 6—8 × 3.5—4 μ, elliptic-ovoid, rusty brown in Melzer's reagent, walls somewhat thick; basidia 16—21 × 4—7 μ, 4-spored; cheilocystidia clavate, 19—21 × 4.8—9.6 μ; pleurocystidia none; pileus trama very loosely floccose; cuticle of patches of thick-walled brown pilocystidia up to 400 μ long and 10—15 μ wide; clamp connections present.

Gregarious in cedar swamps: August and September.

Observations: The species which Kauffman (1918) called *L. felina* in Michigan he later (1924) transferred to this species. As treated here *L. fuscosquamea* is considered coarser and paler than *L. felina*, the annulus is not as distinct, and the stipe is much scalier.

Lepiota roseotincta A. H. Smith

Pileus 2.5—3 cm. broad, convex or with a flattened disc, surface appressed-fibrillose, the fibrils arranged in appressed fascicles near the margin, disc "deep Corinthian red", marginal area streaked with "Corinthian pink" fibrils, ground color white, surface quickly staining bright orange when bruised, portions soon becoming blackish; flesh thin, soft, white, unchanging, odor not distinctive, taste mild.

Lamellae reaching the stipe at first, usually becoming remote in age, close to crowded, moderately broad, white or evenly flushed pink toward the margin of the pileus, not staining when bruised, edges even, 1—2 tiers lamellulae.

Stipe 3—4 cm. long, 4—5 mm. thick at the apex, slightly clavate-bulbous but tapered to a long point below (almost fusiform sometimes) hollow, fragile, white within, surface delicately white-tomentose, the fibrils quickly staining reddish orange when bruised, the stains eventually becoming sordid brown; annulus median, membranous, white with scattered pink fibrils on the under side.

Spores 7—10 × 4—5 μ, narrowly subovoid with an oblique apiculus and a somewhat pointed apex, smooth, rusty brown in Melzer's reagent; basidia 4-spored; cheilocystidia 36—48 × 9—14 μ, abundant, forming a sterile band along the edge of the gill, fusoid-ventricose with obtuse apices, smooth, hyaline in water or KOH mounts; pleurocystidia none; gill trama homogenous, hyaline to pale yellow in Melzer's reagent; pileus trama homogenous, cuticle an irregular layer of more or less irregularly arranged hyphae having sordid reddish contents in KOH and measuring 8—15 μ thick.

Gregarious on debris at the base of a basswood tree. September. Rare.

Observations: The quick color change makes this species easily identified. As in *L. flammeatincta* Kauff. the color change seems to be confined to fibrils of the surface from the universal veil. In *L. flammeatincta* the original colors reappear, whereas in *roseotincta* the bruised portions become blackish. *L. roseifolia* Murrill has a quick color change. This is confined to the gills, however.

Lepiota olivacea Kauff.

Pileus 4—7 cm. broad, campanulate, expanding and soon plane or depressed, sometimes subumbonate, innately radially fibrillose, unpolished, "dark olive" on disc, "light grayish olive" to "olive gray" elsewhere; flesh thin, soft, white, unchanging, odor and taste not distinctive.

Lamellae remote from stipe at least in age, ventricose, 5—6 (7) mm. broad, edge fimbriate.

Stipe 5—6 (7) cm. long, 3—5 mm. thick at apex, equal or enlarged to a subbulbous base 10 mm. thick, silky-stuffed becoming hollow, glabrous, white, silky shining above; annulus median, membranous, erect-flaring at first.

Spores 6—7.5 × 3—4 μ, ovoid-ellipsoid, rusty brown in Melzer's reagent (in a collection made in 1933 from the same locality as the type was found the spores were 6—10 × 4—4.5 μ, variable in size

and shape, mostly elliptic ovate but many somewhat angular and some almost rhomboidal); basidia 4-spored, 25—27 × 8 μ; cheilocystidia 24—33 × 12—19 μ, clavate; pleurocystidia none; gill trama interwoven; pileus trama floccose, cuticle of appressed hyphae many of which have a bluish gray content when revived in KOH clamp connections numerous.

Inwoods. September. Rare.

Observations: This is the only green Lepiota so far known from Michigan so should be easy to recognize if found. The angularity and variation in size and shape of spores in the 1933 collection is unusual in this genus.

LEPIOTA RUBIDA Kauff.

Pileus 2—4 cm. broad, thin, subumbonate, campanulate-expanded with a continuous, separable, subviscid cuticle, radially innately silky, delicately pink, sometimes shading to white toward the margin; flesh pure white, unchanging, thin, fragile, odor and taste not distinctive.

Lamellae somewhat remote from stipe, crowded, narrow, pure white.

Stipe 5—9 cm. long, 3—5 mm. thick, tapering upward from a subclavate bulb, stuffed, soft, dry, glabrous; annulus median, membranous, thin, white, at length pendent, subpersistent.

Spores (5.5) 6.6—7.5 (8.4) × 2.8—4.2 μ, elliptical, the walls thickened more toward the apex, very dark chocolate brown in Melzer's reagent, plage conspicuous by being paler than the remainder of the wall in iodine; basidia 20—26 × 4.2—6.3 μ, 4-spored; cheilocystidia 30—40 × 6—10 μ, clavate, numerous; pleurocystidia none; gill trama compact, not divergent, hyphae very narrow; pileus trama thin, white compact, cuticle of radially arranged appressed hyphae 3—4 μ in dia., pointed at the free end, not at all gelatinous when revived in KOH.

Gregarious on the ground, in swamps, elm woods and under hemlock. September. Rare.

Observations: Kauffman (1918) reported this as a variety of *L. delicata* Fr. then decided that it was a new species. The description of the pellicle as subviscid suggests its affinities to Limacella. However a microscopic study of the cuticle of revived material shows no tendency toward gelatinization and the gill trama is not divergent.

LEPIOTA RUBROTINCTA Peck

Pileus (2) 3—6 cm. broad, buttons ovoid but slightly flattened at times at apex, expanding to broadly convex, nearly plane or with a low obtuse umbo, cuticle at first continuous over pileus but becoming rimose near the margin and breaking up into fine colored squamules toward the disc, disc usually remaining smooth or nearly so, bright reddish-pink ("light coral red") to purplish around disc, "salmon color" to "salmon buff" toward margin (paler toward margin); flesh thin, white, unchanging, odor and taste not distinctive.

Lamellae close, narrow to moderately broad, white, unchanging, edges slightly flocculose.

Stipe 4—9 cm. long, 3—8 mm. thick, equal above, narrowly clavate at base, stuffed, becoming hollow, white throughout and glabrous or

slightly silky-fibrillose; annulus median to superior, well developed, persistent, flaring or ascending and often tinged with rose along the lacerated margin.

Spores 7—10 × 4.5—5.5 μ, white in mass, dark rusty brown in Melzer's reagent, slightly inequalateral in side view, ovoid-pointed in face view, apiculus prominent, wall thickened; basidia 18—22 × 6—7 μ, 4-spored; cheilocystidia abundant, filiform and 30—40 × 3—5 μ, often flexuous or contorted, some clavate to subcapitate 32—38 × 5—7 μ, also flexuous, some fusoid-ventricose and 22—34 × 5—8 μ, very few reaching 10 μ broad; pleurocystidia none; gill trama of loosely interwoven hyphae, subhymenium cellular, cells 5—10 μ in dia. with an unstable pigment; pileus trama loosely filamentose, cuticle of radially arranged fibrils 4—6 μ in dia. with an unstable pigment; clamp connections none.

Singly or scattered on the ground, usually on humus, under conifers or hardwoods. August and September. Rather common in the southern part of the state.

Observations: The slightly larger *L. rubrotinctoides* Murrill described from the Pacific Coast appears to be identical with this species.

Lepiota alluvinus Peck

Pileus 1—4 cm. broad, obtuse, becoming convex to plane or slightly umbonate, dry, surface breaking up into fine flat, imbricate-fibrillose yellowish scales, white flesh showing between them, margin somewhat striate, buttons "sulfur yellow"; flesh very thin, odor and taste not distinctive.

Lamellae fairly remote from stipe, crowded, moderately narrow, white, edges white.

Stipe 2—6 cm. long, 3—5 mm. thick, bulbous, loosely stuffed by a white pith, "sea foam yellow" (pale yellowish white), glaborus or with faint yellowish fibrillose patches, flesh faintly yellow; annulus superior, thin, membranous, sulfur yellow, perisistent, not moveable.

Spores 7—8 × 4—4.5 μ, rusty brown in Melzer's reagent, thick-walled, no germ pore; basidia 4-spored, clavate; cheilocystidia 18—29 × 4.8—10 μ, clavate or fusoid-ventricose; pleurocystidia none; gill trama very compact, subparallel; pileus trama very thin; cuticle of narrow, appressed hyphae.

Gregarious on ground under conifers. August. Rare.

Observations: This species is apparently quite similar to *L. miamensis* from which it is chiefly distinguished by its yellow color.

Lepiota pulcherrima Graff sensu Kauff., Pap. Mich. Acad. Sci., Arts and Letters **4**: 334. 1924.

Pileus 1—4 cm. broad, subconic-campanulate, becoming expanded-plane and obtuse, cuticle on drying sometimes becoming finely silky or minutely diffracted-scaly, very bitter, subviscid, white; flesh thin, white, unchanging, odor not distinctive.

Lamellae approximate to stipe, crowded, narrow, white, edges even.

Stipe 5—8 cm. long, 2—4 mm. thick at apex, enlarging below to 4—8 mm. thick, stuffed with silky fibrils, becoming hollow, surface

innately silky or fibrillose-scurfy below the annulus and this layer bitter to the taste; annulus superior, membranous, narrow, erect-flaring, sub-persistent.

Spores 5—7 (7.5) × 3—4 m, oval-elliptical, smooth, hyaline, pale brown in Melzer's reagent; basidia 12—30 × 5—7 μ, clavate; cheilocystidia 10.5—16.8 μ, clavate, very numerous; pleurocystidia none; gill trama interwoven, hyphae very narrow; pellicle of appressed radial fibrils 5—7 μ in dia. with frequent septae, no evidence of gelatinizing when revived in KOH: clamp connections none.

Low moist ground under Impatiens and Sambucus. August. Rare.

Observations: This is described as having a subviscid pellicle but it does not gelatinize when revived in KOH, and the gill trama is interwoven. These characters prevent the placement of this species in Limacella.

LEPIOTA MIAMENSIS Morg.

Pileus 2—4 cm. broad, convex-expanded, subumbonate, even, fibrillose-scaly except on disc, white or whitish, usually brownish on disc; flesh very thin, soft, fragile, white, odor and taste not recorded.

Lamellae rather broad, ventricose, rounded behind, white.

Stipe 3—5 cm. long, 2—4 mm. thick, subequal, often compressed, glabrous or pruinose at apex, white; annulus median, thin, fragile, subpersistent.

Spores 5—6 (6.6) × 3—4 μ, amydaliform, wall thick, no germ pore, yellow to pale rusty brown in Melzer's reagent; cheilocystidia clavate or ventricose, 16—24 × 9—12 μ, some gill edges apparently fertile; pleurocystidia none; gill trama compact, cellular to subparallel; pileus trama floccose; cuticle a compact layer of slender ± appressed hyphae 2—8 μ wide.

On ground in woods. August, September. Rare.

Observations: when dry the pileus is whitish with a brownish center.

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Davidia as the Type of a New Family Davidiaceae

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Davidia is a distinct and unique genus assigned to the Nyssaceae. Various authors have made intensive morphological and anatomical studies on this genus, and their conclusions are invariably that it is an isolated genetic stock rather distinct from the other genera of Nyssaceae, *Nyssa* and *Camptotheca*, and other associated families. It has not been given familial rank because of the general prejudice against recognizing small or monotypic families.

The genus was established by Baillon (1871) who placed it with *Nyssa* and *Camptotheca* in the Nyssaceae. Harms (1897, 1898) placed the genera *Davidia* and *Nyssa* among the Cornaceae treating them as the subfamilies Davidioideae and Nyssoideae respectively. In Wangerin's treatment (1910), *Davidia* is again associated with *Nyssa* and *Camptotheca* constituting the family Nyssaceae as first proposed by Baillon. Wangerin regards the two genera *Nyssa* and *Camptotheca* as closely associated with each other and together they form one subfamily, while *Davidia* occupies an isolated position forming another subfamily. However, he considers the position of *Davidia* as doubtful as it is quite different from the other two genera and suggests that it might be made the basis of a distinct family.

Horne (1909) investigated in detail the structure of the inflorescence of *Davidia* and its phylogenetic affinities. (Illustrations showing all details are given in his paper which may be referred to for further information). He thinks that the nearest resemblance is to the Nyssaceae and Alangiaceae but states that "the organization and structural detail of the inflorescence and flower of *Davidia* are peculiar and do not indicate *close** affinity with *Nyssa* and *Alangium*. The genus occupies a somewhat isolated position, and may be regarded as having evolved along independent lines from the plexus of Araliaceae, Nyssaceae, and Alangiaceae".

Titman (1949), in studying the wood anatomy, is in agreement with the suggestion by Wangerin and others that "*Davidia* may be only remotely (if at all) related to the sub-family Nyssoideae. The remoteness of *Davidia*, morphologically and anatomically, is so complete as to make possible the conjecture that development within the family has been polyphyletic". He finds that *Davidia* shows more primitive characters than the other genera in the more primitive heterogeneous type of ray, longer vessel length, greater number of perforations of the vessel plate, etc.

The most distinct and unique features of *Davidia* are the flowers and inflorescence, both very unlike those of *Nyssa* and *Campthotheca*. There are two very large white bracts at the base of the inflorescence which is a subglobose head densely beset with numerous small staminate flowers and one perfect flower situated laterally above the middle toward the tip. The flowers are andro-monoecious and apetalous,

*Italics original.

very different from the petalous polygamo-dioecious flowers of the other two genera. The ovary is many-celled instead of one-celled. The structure of the flower and inflorescence of *Davidia* suggests little close affinity with any other group of plants. This genus is indeed an isolated one representing probably an independent line of development from primitive forms that give rise to the families Nyssaceae, Alangiaceae, Araliaceae, and Cornaceae. It is here proposed as representing the type of a distinct family, the description of which follows.

The name Davidiaceae is used by Erdtman (1952) in his work Pollen Morphology and Plant Taxonomy, who discusses the Nyssaceae and says that (p. 289) "*Davidia* differs in several respects, including pollen morphological ones, from *Camptotheca* and *Nyssa* and may not really belong to the same family as these." Earlier in the same work (p. 144) the name "Davidiaceae (see Nyssaceae)" is listed. Inasmuch as this is not referred to a previously published record, and as *Davidia* is repeatedly listed in the same work under Nyssaceae (pp. 288, 289, 424), the name Davidiaceae given by Erdtman can not be considered as a validly published name. Apparently Erdtman did not intend to publish a new family name according to the International Rules of Botanical Nomenclature.

Davidiaceae, fam. nov.

Cornaceae subfamily Davidioideae Harms in Ber. Deutsch. Bot. Ges. 15: 28. 1897, in Engler & Prantl, Natur. Pflanzenf. III. 8: 255. 1898.

Nyssaceae subfamily Davidiodeae Wangerin in Engler, Pflanzenreich **41** IV. 220a): 17. 1910.

Arbor decidua, ramulis rectis vel adscendentibus; foliis simplicibus alternatis, graciliter petiolatis, dentatis, prominente penninervatis, Flores andro-monoeci, apetali, in capitula terminalia pedunculata. bracteis 2 suboppositis foliis conformibus aequalibusque subpetaloides albis demum patentibus involucrata dispositi.

Flores masculi e staminibus tantum formati; staminia ∞ in capitulum globosum minute foveolatum, filamenta libera subulata plerumque 5-vel 6-fasciculata foveolis receptaculi inserta; antherae introrsae, loculis ovatis. Flores hermaphroditi in capitulis singuli vel obsoleti, lateraliter supra medium capituli inserti; receptaculum ovoidenum, ovario adnatum; perianthium nullum, staminibus ∞ vel paucis filamento brevi insertis; ovarium supernum 6–9–1oculare, supra in stylum conicum rugosum apice in lobos stigmatos loculorum numero aequales raditos divisum; ovula in loculis solitaria, paulo infra apicem angulo interno inserta, descendentia, anatropa, micropyle extrorsem supra. Fructus drupaceus, obovoideus vel ellipsoideus, in sicco brunnescens vel rubescens, mesocarpio granulato-crustaceo, endocarpio osseo longitudinaliter sulcato, 3-5-loculari, loculis 1-spermis. Semen pendulum, endospermio carnoso, embryonis erecti cotyledonibus oblongis, radicula cylindrica.

The family includes one genus with one species, *Davidia involucrata* Baill. in central and southwestern China. An attempt to differentiate the genus into three species (Dode 1908) proved unsuccessful and the genus is now considered by all as monotypic with one species and one variety (Hemsley 1907, 1909, Wangerin 1910, Wilson 1914).

Davidia involucrata Baill. occurs in northwestern Yunnan, Sikang, Szechuan, Kweichow and western Hupeh in moist woods at medium to high altitudes, attaining a height of about sixty feet with a girth of trunk of three feet. Variety *vilmoriniana* Hemsley (*D. vilmoriniana* Dode) occurs in approximately the same range and differs from the typical form of the species only in the more glabrous leaves (Wilson 1914).

Both the type and variety were introduced into cultivation through the effort of Wilson who collected seeds of *D. involucrata* var. *vilmoriniana* in 1899–1901, and of *D. involucrata* in 1903 and 1904 (Wilson 1914). Variety *vilmoriniana* proves to be hardier and probably all plants cultivated in the eastern United States belong to this variety.

In regard to *Davidia involucrata* var. *vilmoriniana*, Wilson (1914) states that "Formerly I was inclined to believe that this tree might represent a second species but subsequent observation has convinced me that it is nothing more than a glabrous-leaved variety of the type. In adult trees there is no other difference between the type and the variety; in the juvenile state even this disappears and the only distinguishing character is the colour of the young shoots which is dull grey or slightly purplish in the variety and dark red on the type."

However, Cocker (1952) and Ivens (1953) drew attention to the difference in the fruit between *Davidia involucrata* and *D. involucrata* var. *vilmoriniana* on plants cultivated in Italy and England respectively. They noted that the fruits of the typical form are round or oblate, dark green, and inconspicuously speckled with netted russet. Those of the variety are much larger, more oval in outline, apple-green, and inconspicuously speckled with minute russet dots. These differences, apparently hitherto unrecorded, raise the question whether *D. involucrata* var. *vilmoriniana* actually deserves specific rank. Only fresh fruits of *D. involucrata* var. *vilmoriniana* were observed by the present author. The fruits are oval, apple green, measuring about 3.3 cm. long and 3 cm. wide, and the russet dots are rather conspicuous. The fruit is also inconspicuously ridged longitudinally. It will be necessary, however, to study the variation of these characters in plants growing in their natural habitat to ascertain their taxonomic significance.

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Notes on Lycium (Solanaceae)

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In working over the material of *Lycium* in the herbarium of Fundación Miguel Lillo, two recent collections from Peru, seem sufficiently distinct to warrant description:

Lycium chilense var. **peruviense** Barkl., n. var.

Frutex 1.5 m. altus, ramis gracilibus glabris pungentibus; folus lanceolatoellipticis acutis parce ciliatis 5–15 mm. longis, 1–4 mm. latis; calyce glabro, tubo 2 mm. longo, lobis cilialis 1 mm. longis; corolla ad basin extus pubescente, inter stamina intus barbellata; staminibus 1mm. supra basin tubi corollae affixis; glandula ad basin staminum posita, margine pilosa; fructu ovoideo 4 x 6 mm., parte 1 mm. basali styli ampliata.

Shrub 1.5 mm. tall with delicate pungent branches; branches glabrous, at first greenish-gray, later tan; leaves lance-elliptic, acute, sparsely ciliate, 5–15 mm. long, 1–4 mm. broad; pedicels glabrous, 4–6 mm. long; calyx glabrous, tube 2 mm. long, lobes ciliate, 1 mm. long; corolla pubescent outside at base, very sparsely pilose above, with a tuft of hairs inside between stamens, tube 3 mm. long, lobes 5 mm. long, ciliate; stamens attached 1 mm. from base of tube of corolla, gland 1 mm. long at base of filaments, pilose on margins of gland, filaments 4 mm. long, anthers 2 mm. long; style 4 mm. long, persistent in fruit; fruit ovoid, 4 by 6 mm., lower 1 mm. of style enlarged.

The persistent style bases on the fruits set this apart from the typical variety and the other varieties known to the writer.

Type: Peru: Coquimbo: Illapal: Questa Espino, Aloa Parpsa, alt. 1000–1100 m., 19 Oct. 1945, W. Biese 2206 in the herbarium of Fundación Miguel Lillo (No. 137626).

Lycium Biesei Barkley, n. sp.

Frutex multiramosus, spinis crassis; folus 1–5, fasciculatis; floribus per nodum 1–3; pedicellis ca. 2 mm. longis, pubescentibus; calyce parvo, tubo minute pubescente ca. 1.5 mm. longo irregulariter 4-lobato, lobis ca. 0.5 mm. longis ciliatis; tubo corollae ca. 11.5 mm. longo, ad apicem ca. 3 mm. diametro, ad basin 1 mm. lato, infra stamina intus piloso, cetera glabra, lobis 4, 1.5 mm. longis obscure ciliatis; staminibus 4 non exsertis; filamentis ad partem quartam basalem tubi corollae adnotis, in dimidio infero parce pubescentibus.

A very leafy, much branched, sparingly pubescent or glabrate shrub, with branches slender to heavy, straight or crooked, gray to dark gray, spines heavy, increasing in thickness; leaves 1–5, fascicled on

PLATE 1.—A-D. *Lycium Biesei* Barkley. A. A branch showing spinose branches, shortshoots, leaves and flowers. X1. B. Calyx showing pubescence. X 2.5. C. Corolla opened to show the stamens. X 2.5. D. Leaf showing the minute pubescence. X 2.5. E-J. *Lycium chilense* var. *peruviense* Barkley. E. Branch showing fruit. X 1. F. Calyx. X 2.5. G. Corolla opened to show the stamens. X 2.5. H. Leaf showing the ciliate pubesence. X 2.5. I. The base of the stamens showing the glands and pubsescence. X 5. J. A branch showing the spinose branchlets, the leaves and the flowers. X 1. (Drawings by Estella Vaca).

short-shoots, linear-spatulate to narrowly spatulate-obovate, somewhat fleshy, minutely pubescent, base long-attenuate; flowers 1–3 at the nodes, pedicels about 2 mm. long, pubescent; calyx small, tube cup-shaped, minutely pubescent, about 1.5 mm. long, irregularly 4-lobed, lobes about .5 mm. long, ciliate; corolla very narrowly tubular-obconic, tube about 11.5 mm. long, about 3 mm. in diameter at the summit, about 1 mm. broad above ovary, glabrous externally, very sparsely pilose inside below center to the point of attachment of the stamens,lobes 4, rounded, 1.5 mm. long, obscurely ciliate on the margin; stamens 4, not exserted, equal or subequal, filaments adnate one fourth up from the base of the corolla tube, sparsely pubescent in the lower half of their length; style not exserted.

TYPE: PERU: ANTOFAGASTA: TALTAL: Arbusto de dos metros con flores blancas, abundante, Rincon, 12 kms. al norte de Paposa, 2 Diciembre 1944, W. Biese 559, in the Herbarium of Fundación Miguel Lillo (No. 113420).

While this species varies in several respects from *Lycium Giliesianum* it might be considered a variety of that species, except for the very different position of attachment of the filaments.

The author is indebted to Dr. Harold N. Moldenke for the Latin descriptions.

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New genera, species, etc., are indicated by *italics*.